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CHILD DEVELOPMENT

In this number there are six articles: two on the behavior of the new-born infant; one on the infant during first year; three on the pre-school child.

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CHILD DEVELOPMENT

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Excellence of Production and Types of Movements in Drawing

CHARLOTTE RICE

THIS paper reports an analysis of the type and direction of lines chosen by children[1] in the copying of the Binet-Simon diamond in both vertical and horizontal positions and under varying conditions.

Although much observation and no little experimental work has been carried on in the field of children's spontaneous drawing, very little if any work has been done on the factors involved when a child sits down with the definite task of copying something set before him. And what analysis has been done on experimental results of the latter sort has been to the end of evaluation of the results in terms of adult ideals of perfection. No small part of this work has been done in the field of education through experiments in teaching beginners to write as illustrated by the reports of Huth (3) Gates and Taylor (1) Hertzberg (2). Other studies to a large extent are confined to the comparison of the orientation and similarity of the child's finished product to the pattern from which it is copied, notably by Stern (5) and Paula Meyer (4). Among none of these experiments and observations has there been any attempt on the part of the experiment to obtain an idea of the manner in which the child did the actual manipulation of the materials to get the result.

In 1926 Wellman, defining the directions of the lines to be drawn, made a very careful analysis of the influence of direction of movement on the control of hand and arm in a group of young children. She found certain directions of movement (↘ and ←) in general much more difficult than others. But so far as the writer has been able to determine, no work has as yet been done in the actual choices of kinds and directions of strokes made by young children in their attempts to copy plane figures, and the relation of these choices to the perfection of the result as judged by an adult standard, which is unfortunately the only standard available at present for such judgment.

[1] The investigation was made in the Psychology Laboratory of the Johns Hopkins University in 1928 and 1929 supplemented by data obtained in a summer at the Institute of Child Welfare, Minnesota. The author is making a further study at the University of California of the child's judgment of the excellence of the production.

DESCRIPTION OF TEST

The materials for the test consisted simply of a white card, 4 by 5 inches on which was a black ink drawing of a diamond $2\frac{3}{4}$ inches (long axis) by $1\frac{1}{2}$

inches (long axis) by 1½ inches (short axis), pencils, and paper for the use of the subject in drawing. Slips of paper torn from pads 3 by 5 inches proved satisfactory for this, by furnishing a size and shape somewhat comparable to the pattern card and convenient for filing. The child was seated comfortably across the table from the experimenter and was shown the pattern with the instructions:

Do you see this (pointing to the figure but being careful not to trace it)? See what a nice picture you can draw for me that looks just like this.

At the same time the slip of paper was layed on the table in front of him in the same position as the pattern card and he was given the pencil. The position and manner of presentation of the pattern card differed at different times according to the demands of the experiment. In the case of all subjects the first exposure was in the horizontal position and according to the instructions given above.

With a certain number of the subjects (groups A, B and C) to be designated below, this procedure was followed immediately by a presentation in the vertical position with the same instructions. Later the same day, after the intervention of a test of recognition of similar forms in which the diamond played a somewhat important part, 2 presentations were given 1 in the horizontal position and 1 in the vertical with a slight change in the manner of exposure. Instead of being asked to copy the figure directly, the child was presented with the pattern card without pencil and paper, and with the following instructions:

I want you to keep looking at this until I take it away. Pretty soon I am going to take it away and hide it, and then I want you to draw me a picture that looks just like it.

If the child's attention wandered, he was admonished to keep looking at the picture. After ten seconds the pattern was taken away, and placed out of sight, while the experimenter said,

Now I'm going to take it away and hide it.

Then, while giving the child a pencil and placing a slip of paper before him in the same position as the pattern card, the experimenter added:

Now see what a nice picture you can draw me that looks just like the one you have been looking at.

In the cases of groups A and B this procedure was followed some time later (in the case of A exactly two weeks; in the case of B periods ranging from fifteen to twenty-four days) by an experiment in which the child was placed before a table over which a screen was set, in such a position that the child could draw under it freely, but at the same time could not see what he was doing if he sat in a normal drawing position. The child was then asked whether he remembered what the picture looked like that he had drawn for the experimenter at the previous period. No matter what his answer, he was given a piece of paper under the screen and a pencil was placed in his drawing hand, while the other hand was placed on the paper to hold it in position. At the same time the following directions were given:

Now I want you to put this hand here to keep the paper from slipping over the table (placing other than drawing hand), and I want you to take your pencil and place it ready to start drawing, but do not draw anything until I tell you what I want you to do (placing the drawing hand with the pencil in it). Now I want you to sit up straight, and look right here (pointing to a place on the upper side of the screen directly in front of the child's eyes), and then, without looking at what you are doing under the screen,—looking right here all the time (pointing again to screen), I want you to draw the same picture you drew for me last time.

No suggestion was made that the figure be drawn in one position rather than another, aside from the fact that the paper was placed before the subject in the horizontal position. Since, however, the child could not see it, even this probably had little to do with the manner in which the drawing was made. Care was taken also to place the drawing hand in as relaxed a position as was possible lest some muscular tension due to the position should in some way influence the direction of the line.

A fourth group of subjects (group D) followed their initial drawing immediately with a group of 10 practice drawings of elements of the figure. At the end of this series the initial stimulus was given again in the horizontal position and the directions were repeated.

A fifth group (group E) followed the procedure of group D exactly, but two months later, with no intervening tests of this nature they were presented with the pattern card in the vertical position and were given identical instructions to those given at the initial presentation.

A sixth and final group (group F) followed the initial drawing, after a period varying from one to eighteen days, with a presentation of the pattern card in the vertical position and a repetition of the initial instructions.

After each drawing, no matter what the conditions under which it was made, a record was placed on the paper of the direction and order in which the lines were drawn. Although times were recorded for each drawing, they have not been treated in the present article, since they only bear indirectly on the point under discussion. The use of the Binet-Simon diamond in this experimentation is not comparable to the use of the diamond in the Binet-Simon scale test, inasmuch as in the latter case the instructions call for the exlusive use of the pen in drawing. Since the aim in the present case was to simplify the task as far as possible in order to reduce distracting factors and facilitate the naturalness of the situation to the child, a pencil, a more familiar tool to the very young child was substituted for pen.

SUBJECTS

The subjects, 293 in all, have already been divided, with respect to the particular procedures which were followed in giving the test, into groups A to F respectively. Table 1 will give the numbers, sources, ages and I.Q. scores in each group. With a few exceptions the children came from professional and better class business homes, and are the type found in good private schools. They show a wide age range, fairly evenly distributed over the years 3:1 to 8:0 and with a sufficient number of scattered cases at the

two ends of the age scale to give interesting indications of reactions at the ages not covered so thoroughly.

TREATMENT OF DATA

1. Scoring results by degree of similarity to pattern

Before analysing the types of movements made by children in drawing a particular figure, which in this case happens to be a diamond, some scheme must be devised whereby the drawings made by the child may be judged with regard to their similarity to the pattern set. To this end the diamonds have been given scores of 1, 2, 3, 4, and 5 points according to their excellency of form. Illustrations are given in figure 1. A score of 1 is given when no attempt to make a copy is evident. This is a usual reaction among the youngest children and almost invariably denotes a lack of understanding of the problem as it is presented. With an understanding of the problem, but a still deficient ability to carry out instructions, the result is a curved line enclosing a space. This is given a score of 2. A score of 3 is given when there is an attempt to produce and a certain degree of success in producing certain of the isolated characteristics which form the diamond, such as straight line boundaries and angles, which begin to narrow the limits of this figure's similarity to others. With the evolution of an inferior diamond, a score of 4 is given. For this score there must be four sides and four angles and a semblance of symmetry, though details of relation, proportion and orientation may be overlooked. With good proportion and

TABLE 1

Subject sources, ages, and I.Q. scores

GROUP NO.		SOURCE	AGE RANGE	MED. AGE	NO. I.Q.	I.Q. RANGE	MED. I.Q.
A	18	Child Institute, Johns Hopkins University	2:7–5:0	3:7	16	104–141	121
	36	Park School, Baltimore, Md.	4:4–8:0	6:9	15	104–125	115
	78	Roland Park School, Baltimore, Md.	3:9–9:3	6:9	46	93–145	114
B	5	Child Institute, Johns Hopkins University	3:1–4:7	3:5	5	78–116	105
	5	Park School, Baltimore, Md.	4:1–9:0	4:11	2	117–130	
	13	Roland Park School, Baltimore, Md.	4:8–6:11	6:4	7	92–134	116
C	1	Child Institute, Johns Hopkins University	4:3		1	135	
	22	Park School, Baltimore, Md.	4:4–7:11	5:9	5	91–116	110
	13	Roland Park School, Baltimore, Md.	5:2–7:11	7:1	7	105–154	116
D	3	Child Institute, Johns Hopkins University	3:11–4:8	4:0	3	111–118	117
	35	Park School, Baltimore, Md.	4:10–11:2	8:1	35	87–144	113
	4	Special examination, Johns Hopkins University	4:2–14:1	8:3	4	83–122	103.5
	6	Children's Aid Society of Baltimore County	10:10–13:4	11:9	6	50–100	88.5
	12	Graduate Students in Psychology, Johns Hopkins University					
E	11	Child Institute, Johns Hopkins University	2:9–5:3	4:2	11	91–158	130
F	31	Institute of Child Welfare, University of Minnesota	2:2–4:11	3:8	31	84–130	107

correct orientation, a score of 5 is given.

With the scale so constructed, table 2 will given an idea of its general relation to the age scale. Since all 293 subjects were given the first test, i.e., the drawing of the horizontally placed diamond from the pattern, under the same conditions, scores for this test alone are used, so obviating the tendency to modify the results which different conditions of presentation might produce. The figures in the table then, will give a good idea of the child's ability to do the task set before him at the time of beginning the experimentation.

As far as 8½ years the figures show a steady and fairly even advance from age step to age step. Beyond this, up to the adult stage, the cases are few and scattering and all those obtaining a score less than 4 may be accounted for by some factor of retardation. It so happened that the body of systematic testing was limited to children of second grade age and below and to the small adult group. Records between the ages of 8 years 7 months and 13 years 6 months appear-

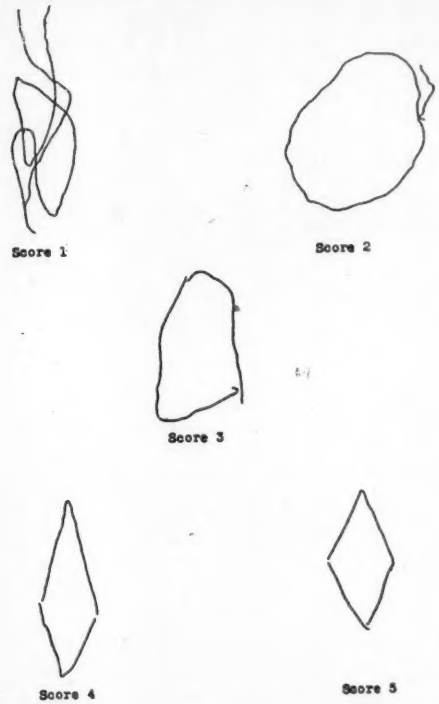

FIG. 1. ILLUSTRATIONS OF SCORINGS FOR DIAMONDS

ing in the data are taken from cases brought into the laboratory for special examination for one reason or another. Many of these turned out to be children of superior intelligence and their

TABLE 2

Distribution of perfection of performance by age: Diamond drawn from pattern in horizontal position

AGES	SCORES				
	1	2	3	4	5
2:1–2:6	4				
2:7–3:0	7	1			
3:1–3:6	9	7			
3:7–4:0	2	8	4		
4:1–4:6	5	7	8		
4:7–5:0	4	9	15	2	
5:1–5:6	0	7	9	6	
5:7–6:0	0	2	13	7	
6:1–6:6	0	1	13	16	
6:7–7:0	0	0	5	20	2
7:1–7:6	0	0	4	22	3
7:7–8:0	0	0	4	17	4
8:1–8:6	0	0	0	5	2
8:7–9:0	0	0	1	9	1
9:1–9:6	0	0	1	2	0
9:7–10:0	0	0	1	0	0
10:1–10:6	0	0	0	0	1
10:7–11:0	0	0	0	1	4
11:1–11:6	0	0	1	0	1
12:1–12:6	0	0	1	0	0
12:7–13:0	0	0	0	0	2
13:1–13:6	0	0	1	0	0
Adult	0	0	0	1	11
Total.....	31	42	81	108	31

scores all fall on 5. The others are of interest mainly in giving added material in proof of the relation of this activity to physical and mental development and to the development both of perception and motor coördination. If we consider individually all the cases between 8 years 7 months and 13 years 6 moths which fall below a score of 4, we find the following facts to be true. In one of these cases the records show no reason other than the objective fact that the body in question was still in the second grade at the age of 9 years 3 months. This boy, with a chronological age of 9 years 3 months and an I.Q. of 101 was quiet and reserved, and showed little interest in the execution of his task. The case in the age group 8 years 7 months to 9 years having a score of 3 is that of a boy of 9 years, still in the first grade, because of a speech defect which made it almost impossible to understand him. No Binet test had ever been given successfully to him, and at the time this test was made, his mental age was not available for comparison. The case in the age group of 9 years 7 months to 10 years having a score of 3 is that of a boy with a Binet mental age of 10 years 10 months but showing a marked lack of muscular coördination, and what we may call for lack of a better term, an inability to perceive objectivitely. He was extremely imaginative, and quite proficient in tasks of composition and verbal creation, but seemed utterly unable to create objective realities with his hands or with tools. The other 3 are all cases of retarded mental development, 2 of the I.Q. scores being low enough to throw the mental ages of the subjects below the 8 years level. In spite of this fact, subsequent attempts by these 3 subjects to draw the diamond, after practising on various elements of the figure in the interim, show performances rating in each case as high as 4 and in one case 5. These

cases present pictures of slow adaptation to a new situation, and are in marked distinction to the 2 cases showing speech and motor defects. While five or six cases are far too few from which to generalize, it is interesting to note that in each case that shows a lower score than one would expect, there is some outstanding factor which may easily account for the situation. It would be interesting to analyse a scattering of cases at the lower end of the age scale to see if superior intelligence might not be the causal factor there, but since in this particular distribution of cases there is no scattering at that end, we cannot at this time do so.

So much for a comparison of the score scale with the age scale. Further interesting material on types of factors effecting excellence of performance, as indicated by such a method of scoring, may be obtained from the summary of inter-correlations and changes in score for individuals when the conditions of operation are changed as found in table 3. Though certain of the correlations in this table are hard to interpret logically, as a rule apparent marked peculiarities may be accounted for by the scarcity of cases. For this reason the actual frequencies and directions of score changes are given in the second part of the table are more illuminating. It must be born in mind also that some of the conditions are not stated in the problem, such as the accumulative practice effect from one set of conditions to the next, which is present even under conditions where practice of drawing the elements of the figure was not included. Nor was the possibility that one figure position might be easier to draw than the other taken into consideration. Very little can be concluded from these figures aside from the fact that the highest correlation seems to be between 2 figures in opposite position, drawn under the same conditions with an interval approximating two weeks between the 2 operations. This set of conditions is undoubtedly that least en-

TABLE 3

Correlations and analyses of score changes between diamonds drawn from pattern in horizontal position and diamonds drawn under other set conditions

CONDITIONS	GROUPS INCLUDED	r	NUMBER OF SCORES		
			Same	Increase	Decrease
From pattern—vertical	ABC	.26 ± .05	130	43	18
After removing pattern—horizontal	ABC	.42 ± .04	132	23	36
After removing pattern—vertical	ABC	.58 ± .03	114	48	29
From memory—under screen—2 weeks after first test	A	.35 ± .05	64	7	61
From memory—under screen—more than two weeks after first test	B	.17 ± .10	10	1	12
From pattern—after practice—horizontal	D	.62 ± .03	46	7	7
From pattern—after practice—vertical	E	.16 ± .19	8	2	1
From pattern—2 weeks after first test—vertical	F	.83 ± .04	27	2	2

cumbered by extraneous factors such as practice effect or memory, which would tend to interfere with the correlation. We may also note—what might well be expected to be the case, that an attempt to draw from memory under a screen, two weeks or more after the first attempts gives a marked decrease in score. Since the experimentation was carried on with other ends in view than the demonstration of the effect of differing conditions on performance, the grouping of subjects is not such that reliable results may be obtained for comparison.

2. Analysis of directions and types of lines used in drawing diamonds

With a general idea in mind of the method of scoring, and the distribution of scores over the age scale, then, it will next be interesting to see what types of strokes are made by these children in drawing diamonds, and to relate the type of stroke used to the score of excellence and to the age.

After studying the performances carefully for some time, it was found that first of all the strokes could be divided into 2 main categories (1) the "continuous line," in which the pencil was not raised from the paper at any time throughout the process of drawing the figure, and (2) the "broken line," in which the outline of the diamond was divided into two or more parts, the pencil being lifted to another point on the paper between successive strokes. This transfer from one point on the paper to another was used as the distinguishing feature, and cases in which the pencil was merely lifted from the paper, then replaced in the same spot, after which the line was continued in the same direction, were considered as continuous lines rather than broken ones.

Given the 2 categories, they were further subdivided with respect to the direction in which the lines were drawn. With the continuous lines this resulted in divisions into clockwise and counter-clockwise strokes. With the broken lines the divisions were with respect to progress of the line to the right, the left, up or down. In general these classifications were dependent on the point to which the pencil was returned before starting the second stroke of the broken line. For example, if the child started drawing at the left hand point of the diamond as it lay in the horizontal position, drew 1, 2, or 3 sides of the figure with a continuous line, then raised his pencil and moved it to the initial point of departure again before drawing the remaining sides, the general direction of the lines of the figure was from left to right, and the diamond is tabulated under the heading "right" in the category "broken line." Similarly if the starting point is at the top, the diamond is tabulated under the heading "down," if at the right, under the heading "left," and if at the bottom, under the heading "up."

It is necessary to say a word further with respect to the interpretation of the 2 major categories in the case of a score of 1, which, it will be remembered, is the score given when the product is nothing but a scrawl. In this case, continuous line may be interpreted to mean a line of roughly circular or oval direction, while broken line includes not only the type of scrawling in which the pencil is often raised from

the paper and in which the lines show no curves, but also the modified type of scrawling which occurs when the child makes only one or two separate lines on the paper. Illustrations of scores in relation to direction and continuity of stroke are given in figure 2. At the outset, there was a question in the mind of the experimenter whether these latter types, especially the last, might not be more mature reactions to the situation than the mere circular scrawl, as also, the broken line drawing of the diamond, a more mature performance than the continuous line.

At some future date, with a much larger body of data with which to deal it will be interesting to analyse the figures which are drawn with broken lines with respect to the manner in which the lines are broken, i.e., whether the first stroke consists of 1, 2, or 3 sides of the diamond, whether the pencil is lifted and transferred only once or more than once in the process, etc. At present such an analysis is

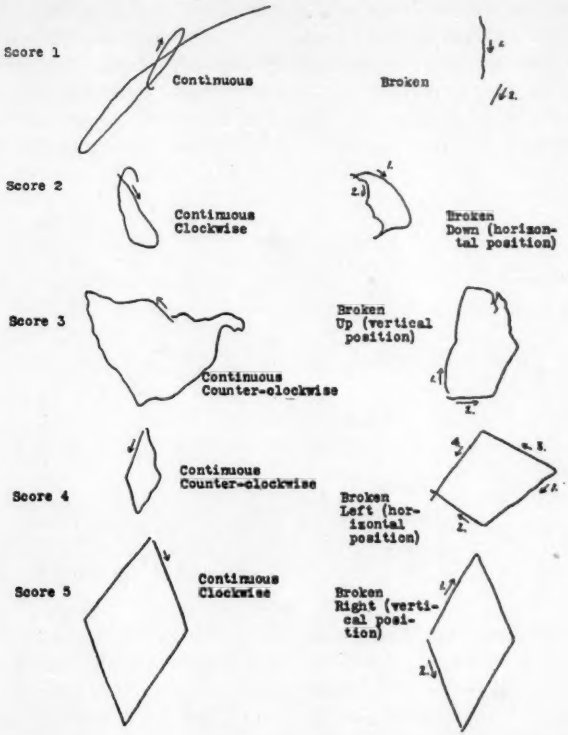

FIG. 2. ILLUSTRATIONS OF DIRECTIONS IN WHICH LINES MAY BE DRAWN

unjustified. The data are too few, and the subjects are not evenly enough distributed over the age levels.

With these factors in mind let us proceed to examine the data under the first 2 main categories, continuous and broken lines. Table 4 gives the frequencies for continuous (column headed C) and broken (column headed B) lines for each score on the diamond, under the varying conditions of the problem. It is interesting to note that under 4 of the 7 conditions of procedure, the trends of highest frequency follow exactly that of the totals as given in the last column, score 2 being the only one in the series which shows a higher frequency for continuous lines than for broken lines. This is easy to understand when we consider that this score represents a circular line or lines enclosing a space. Considering the fact that this score has already been justified as the most immature except for the scrawl, by its position on the age scale, and that the relative difference between the continuous and broken types of drawing increases progressively for the last three scores, it is easy to conclude that as excellence in performance increases, the tendency to draw the figure with a broken line takes precedence over the tendency to draw it with a continuous line. The fact that the broken line gets the majority in score 1 under every condition but 1 is explicable on the grounds that the terms continuous and broken stand for slightly different performances under this score than under the others. It indicates merely that when asked to draw something before they have reached the age when hand and arm muscles can be controlled by perception, children are more apt to scrawl in straight or angular lines than in circles. It is barely possible that this is a first step at imitation of the more controlled motions which an adult uses in drawing. If it is, however, a more advanced state than the circular scrawling it is not justified as such by the relative age distributions of the 2 types of scrawling which appear in these data. In further consideration of the

TABLE 4

Frequencies for continuous (C) and broken (B) line types of drawing for each score under the varying conditions of the problem

SCORES	HORIZONTAL—FROM PATTERN		HORIZONTAL—AFTER REMOVING PATTERN		VERTICAL—FROM PATTERN		VERTICAL—AFTER REMOVING PATTERN		FROM MEMORY UNDER SCREEN		HORIZONTAL—FROM PATTERN AFTER PRACTICE		VERTICAL—FROM PATTERN AFTER PRACTICE		TOTAL	
	C	B	C	B	C	B	C	B	C	B	C	B	C	B	C	B
1	15	16	5	8	3	6	4	8	7	19	3	3	11	7	48	67
2	32	10	19	1	22	0	16	4	15	0	4	1	15	2	123	18
3	29	52	28	47	18	35	24	41	38	39	6	9	1	2	144	225
4	41	67	21	55	24	61	20	45	20	16	15	8	1	3	142	255
5	6	25	1	6	6	16	2	27	0	1	5	17	0	0	20	92
Total....	123	170	74	117	73	118	66	125	80	75	33	38	28	14	477	657

table under discussion, let us examine the 2 columns which deviate most from the total, with a view to determining, if possible, reasons for the deviations. The first of these, which represents the data gathered from drawing the diamond from memory under a screen shows at no place in the 3 highest scores a marked difference between the frequencies. This is undoubtedly due to the opposition of 2 factors, (1) the afore-mentioned tendency with developing excellence of performance to swing over to the broken line method of drawing and (2) in opposition to this the inability without the aid of vision to get back to the initial starting point from some other point on the page. The second of these variations, representing the data gathered from drawing the diamond from the model in the horizontal posi-

TABLE 5

Frequencies for continuous (C) and broken (B) line types of drawing for each age level under the varying conditions of the problem

AGES	HORIZONTAL—FROM PATTERN		HORIZONTAL—AFTER REMOVING PATTERN		VERTICAL—FROM PATTERN		VERTICAL—AFTER REMOVING PATTERN		FROM MEMORY UNDER SCREEN		HORIZONTAL—FROM PATTERN AFTER PRACTICE		VERTICAL—FROM PATTERN AFTER PRACTICE		TOTAL	
	C	B	C	B	C	B	C	B	C	B	C	B	C	B	C	B
2:1–2:6	2	2											2	2	4	4
2:7–3:0	3	5	1	2	1	2	1	2	1	2	0	1	2	3	9	17
3:1–3:6	12	4	8	2	9	1	8	2	3	7	0	0	5	1	45	17
3:7–4:0	8	6	3	0	2	1	2	1	1	2	4	1	7	2	27	13
4:1–4:6	8	12	3	10	6	7	6	7	6	4	2	1	5	2	36	43
4:7–5:0	17	13	8	10	10	8	9	9	9	4	4	1	7	2	64	47
5:1–5:6	14	8	11	6	10	7	7	10	5	8	2	3	0	2	49	44
5:7–6:0	5	17	4	13	2	15	3	14	2	6	2	3			18	68
6:1–6:6	13	17	10	15	8	17	7	18	14	11	4	1			56	79
6:7–7:0	8	19	6	21	6	21	5	22	11	13	0	0			36	96
7:1–7:6	14	15	10	17	11	16	8	19	11	8	1	1			55	76
7:7–8:0	7	18	6	17	6	17	7	16	12	7	1	1			39	76
8:1–8:6	1	6	1	1	1	1	1	1	1	1	1	4			6	14
8:7–9:0	5	6	3	2	1	4	2	3	3	2	2	4			16	21
9:1–9:6	0	3	0	1	0	1	0	1	1	0	0	2			1	8
9:7–10:0	0	1									0	1			0	2
10:1–10:6	0	1									0	1			0	2
10:7–11:0	1	4									2	3			3	7
11:1–11:6	0	2									1	1			1	3
12:1–12:6	0	1									1	0			1	1
12:7–13:0	1	1									1	1			2	2
13:1–13:6	1	0									1	0			2	0
Adult	3	9									4	8			7	17
Total....	123	170	74	117	75	118	66	125	80	75	33	38			477	657

tion after a practice period on drawing elements of the diamond, also has obvious factors which confuse the issue. The experiment, because of the use of the elementary parts, was drawn out to a much longer duration than the experiments carried on under other conditions. The material, after the first novelty was worn off, contained little of interest to the child and the possible factor of fatigue or boredom resulted. The child's aim frequently seemed to be to see how quickly he could finish and leave. This resulted in a more careless performance and may have been an important factor in the increase of continuous line drawings over broken line. On the other hand, in the case of children whose attention held, the practice on elements of the diamond often facilitated the drawing of the final figure. In such cases the use of the continuous line was an actual advance in skill over the use of the broken line.

In short these 2 sets of conditions so obviously modify the results that they need in no way alter the more general conclusions offered above.

Let us consider now table 5 which analyzes in a similar manner the frequencies for continuous and broken lines for each age level under the different conditions of the problem. This gives a very similar picture to the one just examined,—in general, the columns for the individual conditions of performance following quite closely the trend of the column of total responses. Here we have what might be called an uncertain period, between the ages of 3 and 6 years when the trend lines vacillate between the continuous and broken types of lines for some little time before going finally over to the broken type for the rest of the age range. This period coincides with the period on the age scale of greatest frequency for score 3, as may be seen by comparing table 2, a typically intermediate score. The factors causing the variations in the data of col-

TABLE 6

Frequencies of directions of lines in both horizontal and vertical figures, by scores

SCORES	HORIZONTAL						VERTICAL					
	C		B				C		B			
	Clockwise	Counter clockwise	Left	Right	Up	Down	Clockwise	Counter clockwise	Left	Right	Up	Down
1	12	11	3	11	1	12	14	4	1	4	4	12
2	42	24	1	4	2	5	31	26	0	2	1	3
3	41	46	5	60	4	56	25	32	3	14	9	75
4	51	35	14	37	3	82	24	32	4	16	5	93
5	11	1	1	26	0	21	6	2	1	6	0	37
Total.....	157	117	24	138	10	176	100	96	9	42	19	220
Total of left hand drawings.....	9	9	10	4	3	7	4	8	3	3	2	11

umns headed "From memory under screen," and "Horizontal—from pattern after practice" in table 4 are very evidently at work in this grouping of the data as well and may account for such discrepancies as seem to occur in the trends of the two columns in question. Aside from these deviations the same general tendency is obvious in this table,—a gradual change from the continuous line to the broken line as a means to drawing the diamond with the increase in age.

There remains then only to analyse the types of lines in further detail with regard to their direction.

For this purpose a division of the data according to conditions of procedure seems but a confusing complication. The factors at work have already been demonstrated in the previous analysis and can show nothing further if carried over into the finer differentiation, nor will any point be gained by a further analysis of types of line with reference to age groups. On the other hand, a division of the material into horizontal and vertical presentations is obviously much to the point, since a person is quite apt to draw a figure the long axis of which lies vertical, very differently from a figure, the long axis of which lies horizontal, and a pooling of the results of the 2 types would lead to erroneous interpretation. To this end the great majority of the data are already divided by the conditions of presentation. But in the case of the diamonds drawn from memory under a screen no such division exists and they must be separated by inspection. When this is done we find that of the 155 drawings made under the screen, 67 are drawn in the horizontal position, 62 in the vertical position, and 26 are mere scrawls, which can not be assigned a position and so will not be considered in this connection.

In table 6 the frequencies for each direction of line are given for both horizontal and vertical positions, by scores. Considering first only the continuous line drawings, it is evident that for the horizontal position the clock-wise motion is consistently more frequent than the counter-clockwise with the exception of 1 score level. This difference is not so marked in the vertical position, in fact there is hardly enough difference in the latter to warrant its assumption. On the other hand, turning now to the broken line drawings, preference of right over left motions and of downward over upward in both positions is very strikingly consistent and marked. It is also noteworthy that while down motions show the highest frequencies for both positions, they are much higher in comparison to all other motions in the vertical position than in the horizontal. It may be concluded then, that while clockwise motions take doubtful precedence over counter-clockwise, right motions take strong precedence over left, and downward motions take strong precedence over upward. The latter fact is extremely interesting in the face of Wellman's results. She found that lines drawn upward, on the diagonal from right to left tend to show least deviation from a true straight line. While it may be possible for the child to obtain a good result in this direction, it is quite

obvious that he does not often choose it when other possible lines are available.

Hoping to gain still further information on the matter the writer next isolated all the left handed performances from the right handed. The totals for these by type of lines used appear at the base of the table. As might be expected, the relative relation of downward motions to upward remains much the same while the relation of right to left tends quite obviously to reverse and the relation of clockwise to counter-clockwise tends more doubtfully to do the same.

Finally, there seems to be little or no relation between type of movements made and score values.

CONCLUSIONS

In general summary of the results then, we may conclude as follows:

1. There seems to be a fairly close correspondence between increase in point score obtained and increase in age.

2. A general tendency is present for increase in excellency of production as indicated by increase in score to be paralleled by a shift from the continuous line type of drawing to the broken line type, except when extraneous factors such as cutting off of vision during performance, fatigue, or practice effect enter in to make the continuous line type more expedient.

3. A similar tendency is evident for increase in age to be paralleled by a shift from the continuous line type of drawing to the broken line type.

4. There is a slight tendency for clockwise movements to take precedence over counter-clockwise movements in right handed performances, with a possible tendency to reversal of this relation in left handed performances.

5. There is a marked tendency for downward movements to take precedence over upward movements and for right movements to take precedence over left, in right handed performances, with a reversal of the latter relation in left handed performances.

6. Finally direction of movement seems dependent rather on the position in which the figure is drawn than on any excellence of performance.

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Psychophysiological Studies[1]

I. The Technique of Securing Quantitative and Coördinated Psychological and Physiological Data on Lactating Women in Their Usual Home Environment

HELEN A. HUNSCHER, E. LEE VINCENT, AND ICIE G. MACY

EARLY in 1924 a series of studies on the factors influencing the secretion of human milk was begun by the staff of the Nutrition Research Laboratories of the Merrill-Palmer School and the Children's Hospital of Michigan, in coöperation with the Woman's Hospital of Detroit, and later, in coöperation with the psychology staff of the Merrill-Palmer School.

The purpose of this coöperative research was to investigate the relation of physiological, psychological, and social factors to the functions of the maternal organism during the reproductive cycle. In view of the recent widespread interest in the coördination of data in various fields of study,[2] it is hoped that the results of these investigations, as they are reported from time to time, will be of use in demonstrating the integration of diverse data to secure a fairly complete picture of individuals in relation to family groups.

In coördinated studies of this type, there are 2 important methodological problems: First, the development of methods of securing the various types of data without unnecessary duplication and waste, which requires the closest possible coöperation among the advisers representing the various fields concerned, and (which is even more difficult) the securing of a specially trained worker who can secure such all-round data with accuracy and an understanding of all the factors involved and a sympathetic approach to the subjects; and, secondly, the development of methods of reducing the diverse types of data to objective and quantitative terms, with a denominator sufficiently common to permit of coördination and comparison of the data. Throughout the present series of studies, the object has been the detailed study of a small number of cases, paralleled by a study of methods of collecting and analyzing data.

The present paper reports the ex-

[1] From the Nutrition Research Laboratories of the Merrill-Palmer School and the Children's Hospital of Michigan in coöperation with the Psychology Staff of the Merrill-Palmer School, Detroit.

[2] Reports of the Home Problems Conference held at the Merrill-Palmer School, April, 1927; the Conference on Familial Relations, December, 1928; the Conference on Rural Family Relations, March, 1929.

perimental methods devised for and followed in the collection of diverse types of data on women during the periods of pregnancy and lactation, while living in their home environments, with special emphasis upon the methods followed in studying the psychological factors influencing the secretion of milk. Concerning this latter problem, which necessitates coördinated and systematic investigation in chemistry, physiology, sociology, and psychology for its satisfactory solution, little besides advice in the medical literature, based for the most part on general clinical experience, is available. Scattered reports of unusual cases have in some instances led to certain concepts among physicians regarding the stimulating and inhibiting factors in milk secretion and the effects of child-bearing and -nursing upon the maternal organism, but so far as the authors have been able to learn, there has been no attempt to make a comprehensive and coördinated scientific study of the pregnancy and lactation periods of the normal, successful mother living in the home.

The authors hope that the material on the personality of the subjects and the scale for daily recording of the emotions experienced will be of interest to psychologists, and that the report will be of interest to sociologists, not only for the attempted analysis of home environment and family relations, but also as a record of data which the investigator gathered in the homes of the subjects over long periods of time, without exciting animosity or resistance within the family groups.

TABLE 1

Case histories

	SUBJECT VI	SUBJECT VII	SUBJECT VIII
Age in years	27	34	29
Intelligence	Average	Superior	Low average
Parentage	Rural American	Rural American	Rural American
Number of siblings	12	4	12
Educational opportunities	Elementary school	2 years college	Elementary school
Occupation before marriage	Shop worker	Pharmacist	Shop worker
Husband's occupation	Railroad fireman	Salesman	Railroad conductor
Number of children at end of study	4	3	2
Type of home	6-room single	6-room single	6-room single
Ownership	Purchasing	Purchasing	Purchasing

PROCEDURE

The studies were begun by observing patients in the Woman's Hospital during the lying-in period. It was found possible to gain entrance to the homes for the study of the variation in composition of breast milk in relation to the physiological activity, food, emotional reactions, and other relevant factors. After an orientation study on 4 cases at the Woman's

Hospital,[3] a more comprehensive and detailed program of observation was undertaken on 3 women. Table 1 gives the essentials of the case histories of these subjects, VI, VII, and VIII, who were studied throughout their lactation cycles in 1926–27, during the pregnancies that followed immediately in all 3 cases in 1927–28, and in the succeeding lactation cycles in 1928–29, all these periods being almost coincident in time for the 3 women.

The Human Milk Studies have been carried on in the Nutrition Research Laboratories of the Merrill-Palmer School and the Children's Hospital of Michigan, where the physiological (1–10) and clinical phases of the project have been executed. The psychological and sociological phases of the study have been supervised by the psychology and sociology staffs of the Merrill-Palmer School. Other specialists in psychology, sociology, biochemistry, nutrition, medicine, and dentistry have been consulted from time to time throughout the study.

The home contacts were made by one of the writers (H. H.) whose training was in home economics, supplemented by sociology and psychology. The entry to the home was obtained by the Mother's Milk Bureau of Detroit for the purpose of collecting samples for chemical studies on the variation in the composition of breast milk. The observer lived in the homes two days each month during twelve months of the first lactation cycle studied. She supervised the collection of milk, weighed the food eaten by the women, and noted the activities, home atmosphere, and emotional reactions of the women. She avoided the obvious rôle of an observer and assumed that of a friend in assisting with the housework and caring for the children whenever the opportunity arose. Behavior which would limit the usual home activity and conversation was avoided. There is reason to believe that within two months her presence was accepted as a matter of course by all members of the family and that thereafter the spontaneity of the individual and family behavior was uninhibited.

This worker lived in each of the 3 homes during the making of metabolic studies at intervals throughout the 2 lactation periods and 1 pregnancy period. Eight five-day studies and 1 fourteen-day study were made on each subject, thus making a total of 54 full days' residence in each home during two years. Frequent visits of several hours each were interspersed between the longer periods of residence. In addition to the infant, each family had from one to three children, who proved to be sources of information about ways of living in the family and the behavior of individuals in the family group, for they quickly reported any changes that were made in order to make a good impression upon the visitor. Frequent short-time visits were made unannounced, in order to check on the home atmosphere as observed during the scheduled visits in the home. It would seem that with so long a residence in the home and so close a contact with the family, the

[3] The authors wish to express their obligation and thanks to Edith Beck, R. N., Supervisor, for psychological observations and records kept for these preliminary cases during the hospital period.

usual and natural activities would become accessible to observation, and that it is justifiable to consider the behavior pictures of the women recorded under these conditions as fair samplings of their habitual home life.

The subjects have made unusual and valuable contributions through their continuous and untiring efforts in freely discussing their home situations, making diary reports, and keeping records of food and liquid intake, the body weights of themselves and their babies, the quantity of milk produced daily, and the daily emotional reactions. The women were accustomed to call the worker by telephone to report any unusual happenings that they believed to be of significance in the study. We feel that much of this untiring coöperation was due to the fact that the value of accuracy and the significance of the various procedures were thoroughly explained to the women, thus stimulating in them a desire for coöperation with us in the study.

The extent of this coöperation may be measured by the fact that over the period of two and one-half years, during most of which time daily or twice daily records were necessary, Subject VI returned 100 per cent of all possible records, Subject VII, 84 per cent, and Subject VIII, 100 per cent. The failure of Subject VII to return records was in itself a valuable measure, since it seemed to indicate a fundamental personality trait, similar laxities being frequently evident in her home activities.

PSYCHOLOGICAL AND SOCIOLOGICAL STUDIES

The problem of measuring the intellectual traits of the subjects was not difficult, since various fairly successful quantitative measures of intelligence have been made available during the past two decades. The Otis Group Intelligence Scale and the Detroit Alpha Intelligence Test were used.

The problem of measuring non-intellectual traits was more difficult, however, for, though numerous devices have been created in an attempt to measure such traits quantitatively, none seemed to serve adequately for such a study as this one.

The purpose of the psychological and sociological phases of these human milk studies was, then, two fold: First, that of observing the relation of the psychological condition of women to their milk secretion, and second, that of devising a plan for observing and recording daily emotional reactions and other personality traits in a specific and quantitative manner so that they could be correlated with the quantity and quality of milk produced by the subjects.

Since the inception of this project four years ago several studies on the psychophysiological relationship have been started and reported in the literature. A review of the change in attitude from the psychological to the biological as an approach to the study of personality is given by Rich (11), who has made a challenging attempt to approach the problem from the viewpoint of biochemistry. In view of this increasing interest in the psychophysiological approach it seems advisable to report at this time the methods devised for use in the present long-time study.

The case history method was used in the initiation of the project. The

periods of residence in the homes and the various visits gave the worker an opportunity to obtain such biographical material as the physical and mental background of the family, the nature of the home training, early life with siblings and playmates, and opportunities for social and educational experience. The emotional stability, honesty, optimism, psychic drive, sociability, sense of reality, extroversion or introversion, self-estimation, and self-control of the subjects were estimated by the worker after long acquaintance with them. The subjects described their own general temperament in regard to temper, general irritability and control, strength of sex urge, sociability, special talents, and emotional stability.

The 4 standardized tests[4] for the rating of personality and emotional stability which were administered yielded a general picture of the individuals and of the probable reaction of the women as determined by evaluation of usual conduct, but gave only a limited analysis of details and of changes in emotional behavior. The descriptive personality method of the case history depicts in a general manner the reaction tendencies noted by the observer. On the other hand, this method does not allow for daily variation in the nature and intensity of the reactions, a record of which is necessary to the understanding of the emotional make-up of the individual in a continuous long-time study. It was necessary, then, to devise some means of recording the daily emotional pattern quantitatively in such a way that the changes in emotional behavior might be correlated with one another and with the measurable changes in physiological behavior, e.g., the quantity and quality of the milk secreted and the chemical composition of the blood and urine.

Several methods of recording the daily emotional pattern were tried before a satisfactory one was secured. Early in the study the general ratings were supplemented by daily reports of activities and reactions made by the women themselves. These were in the form of a one-page report (Plate I) designed to record variations in emotional response as measured by the presence or absence of five emotional states, i.e., temper scenes, worry and anxiety, melancholy, hilarity, and excitement, with a small space provided for a description of the incident accompanying or causing the emotion. The results showed that this method was not practicable. The subjects lacked both the time and the vocabulary to compose a daily essay report of their emotional responses; they found it difficult to classify the adjustments of the day under the headings provided; the amount of writing required and the difficulty of classification led to incomplete or neglected reports; and frequently only one incident of the day was reported when those preceding or following it may have had more influence in determining the general emotional pattern.

To avoid some of the difficulties inherent in this form of report, the women were asked to write a narra-

[4] The Pressey X-O Tests, the Laird Personal Inventory Tests, the Social Intelligence Tests of the George Washington University Series, and the Allport Ascendency-Submission Study.

PLATE I

Name.....

Date.....

VIII. 5. *Daily Report* (One sheet each, covering 20 consecutive days)

a. Emotional picture. Record instances of:

1. Temper scenes.....

.....

.....

2. Worry and anxiety.....

.....

.....

3. Melancholy.....

.....

.....

4. Hilarity.....

.....

.....

5. Excitement.....

.....

.....

b. Quality and quantity of milk if measured.....

.....

.....

c. Physical condition.....

.....

.....

d. Relevant incidents.....

.....

.....

tive of their daily activities and reactions in the form of a daily diary, but the lack of time, inclination, and command of expression limited the success of these accounts also. One woman with many home duties found the necessary time and enjoyed writing of her family routine and disturbances. On the other hand, another frequently found so little to write, other than "usual day," that her diaries proved useless as a record of presence or degree of emotional activity or reactions. Again, though the diary type of report provided opportunity to record and describe emotions and their stimuli, there was no way of estimating the degree of response or of classifying the records either quantitatively or qualitatively.

It was evident that what was needed was a scale which would permit the subject to rate and record her own emotional states and which would have uniform classifications and cover a definite time period, but would allow for the recording of different degrees of intensity in the emotional experience. A self-rating device was considered essential, not only because it was impossible to keep a worker in the home constantly, but also because even intimate contact with the subject might not reveal her actual feelings to the observer, owing to the fact that the adult habitually conceals certain reactions from social habit and that the difference in range of experiences in subject and observer introduces a large personal margin.

In devising the scale, therefore, the special requirements of a self-rating device were considered. Adjectives descriptive of personality traits and emotional responses were analyzed to determine those which one would most often use in describing one's self rather than another person, and this selected list was compared and combined with descriptive words used by the women themselves in their diary records. The words used in the scale are therefore those common to the layman or non-academic person, but the meanings and classifications have definite values. The words selected are descriptive not of such total personality traits as stability, self-control, good-naturedness, and the like, but of personal and specific responses to situations which are likely to vary from day to day. Care was taken to include fear, anger, joy, love, worry, and excitement, and to consider the possibility of estimating them quantitatively, since these states are especially mentioned by medical writers as factors influencing the secretion of milk.

It was believed that these daily records, kept over a long period of time, would permit a sounder judgment of total personality traits than would more subjective ratings made by either the worker or the subjects. The material obtained by the case history method was checked against these daily records, and the records themselves were checked against ratings made by the worker on the basis of both types of record.

Twelve pairs of adjectives, each pair describing opposed emotional states (e.g., *good-natured* and *cross*), appear on the scale. Each of these pairs is scaled in 5 divisions, to show the differential intensity of the emotion. Thus a check at either extreme of the 5 divisions indicates a

PLATE II

DAILY REACTIONS

Subject:
Date:

Merrill-Palmer School
Nutrition Research Laboratory

Afternoon

Energetic					Listless
Pessimistic					Optimistic
Afraid					Secure
Happy					Dejected
High-strung					Relaxed
Pleased					Disgusted
Carefree					Worried
Indifferent					Affectionate
Good-natured					Cross
Discontented					Content
Ardent					Apathetical
Tired					Rested

REMARKS: Did you lose your temper? Yes..... No.....

Evening

Energetic					Listless
Pessimistic					Optimistic
Afraid					Secure
Happy					Dejected
High-strung					Relaxed
Pleased					Disgusted
Carefree					Worried
Indifferent					Affectionate
Good-natured					Cross
Discontented					Content
Ardent					Apathetical
Tired					Rested

REMARKS: Did you lose your temper? Yes..... No.....

NAP IN AFTERNOON: Yes..... No.....
NIGHT SLEEP: .....Hours, Broken....., Unbroken.....
ACTIVITY: Intense....., Moderate....., Light....., Pedometer Reading.....
DREAMS: Many....., Few....., None....., Happy....., Indifferent....., Distressing.....

marked degree of the emotion shown at that end of the scale, a check at the center an absence of either extreme, and a check in the intervening divisions (2 and 4) the presence in a minor degree of the emotion shown at the nearer end of the scale (Plate II).

The method of checking may be illustrated as follows. The pair of opposed emotional states already mentioned, *good-natured* and *cross*, are scaled:

Good-natured — | 1 | 2 | 3 | 4 | 5 — Cross

If the subjects feels extremely good-natured, as opposed to cross, or if she "feels good no matter what happens,"[5] she will check on 1. Perhaps everything is "going wrong," she "wants to jump on the children for nothing at all," she is "truly ill-humored"—then 5, the opposite of 1, is the place to check. On the other hand, if the subject cannot distinguish the feeling described by either adjective, she will check on 3, the zero point of either good-naturedness or crossness. If the children are slightly bothersome, or the family is not going as smoothly as usual, or the subject feels "peeved," she will check on 4, the mid-point of 3 and 5. If the affairs of the day are going fairly well, with few disturbing incidents to destroy a good nature, and she does not feel extremely good-natured, but certainly not cross, she will check on 2.

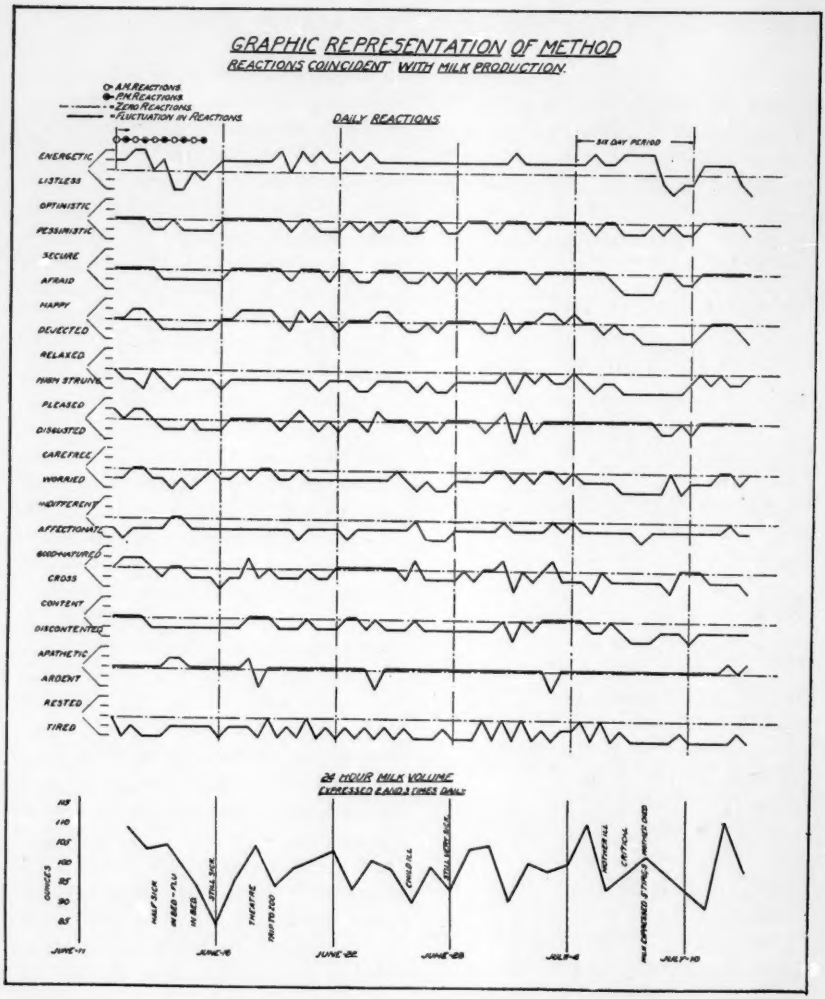
In order to offset any tendency to check consistently on one side or the other of the scale, and to prompt the thoughtful evaluation of each emotional experience represented, the placing of all the favorable emotional states on one side of the scale and all the unfavorable states on the other side was avoided.

The subjects were asked to rate themselves twice daily, at the periods when there was most likely to be quiet in the home and least demand for household activity; that is, in the early afternoon for the morning rating and in the late evening for the afternoon and evening rating. In case the subjects could not check at these times or forgot to do so, they were requested to leave the scale unchecked. Space is provided under the checking scale of each pair of traits for remarks which might throw valuable light on the checking and at the bottom of the form for the recording of other relevant factors, i.e., a loss of temper, the daily pedometer reading, the subject's own estimate of the amount of her activity, the number of hours of rest and sleep, and the amount and type of dreaming.

Several minor revisions of the scale were necessary after it had been tried long enough to indicate individual tendencies in checking among the subjects. Thus analysis of the results showed that certain adjectives caused individual subjects to check invariably on the same division of the scale, and that the substitution of another adjective descriptive of the same emotional state led to a less biased, more accurate evalution. For a period of two weeks, for example, one subject checked on the extreme of *fearless* in the pair of emotional states then described as *fearful* and *fearless*. The accuracy of these reports was questioned and it was thought that the

[5] The quotations are from the diary records of the subjects.

PLATE III


GRAPHIC REPRESENTATION OF METHOD
REACTIONS COINCIDENT WITH MILK PRODUCTION
O=A.M. REACTIONS
●=P.M. REACTIONS
= ZERO REACTIONS
= FLUCTUATION IN REACTIONS
DAILY REACTIONS
SIX DAY PERIOD
ENERGETIC
LISTLESS
OPTIMISTIC
PESSIMISTIC
SECURE
AFRAID
HAPPY
DEJECTED
RELAXED
HIGH STRUNG
PLEASED
DISGUSTED
CAREFREE
WORRIED
INDIFFERENT
AFFECTIONATE
GOOD-NATURED
CROSS
CONTENT
DISCONTENTED
APATHETIC
ARDENT
RESTED
TIRED
24 HOUR MILK VOLUME
EXPRESSED 6 AND 3 TIMES DAILY
OUNCES
115
110
105
100
95
90
85
HALF SICK
IN BED - FLU
IN BED
STILL SICK
THEATRE
TRIP TO ZOO
CHILD ILL
STILL MORE SICK
MOTHER ILL
CRITICAL
MILK EXPRESSED 3 TIMES
MOTHER DIED
JUNE-11
JUNE-16
JUNE-22
JUNE-28
JULY-4
JULY-10

adjectives used might have something to do with the uniformity of the report. Accordingly, the terms *afraid* and *secure* were substituted, and the subject began to show variability in this trait on the checked scale and admitted that the former terms had annoyed her and led her to check as she did.

The response of the women to the rating scale has been very satisfactory. They readily learned how to use it and have found it no burden to check twice daily. According to the subjects, the scale is complete descriptively, and they experience less inhibition in checking it than in describing their emotional experiences in diary form—an observation which is confirmed by analysis of the diary records.

In order that the material might be made more accessible for study the ratings made on these scales were recorded on graph paper, a method of analysis which permits comparison of the physiological data (the daily quantity of milk, and the chemical composition of the milk, urine, and blood) with the data on the daily emotional reaction. In graphing the ratings, the results for the intense emotions were placed at the bottom of the five-step scale, since medical literature seems to indicate that strong emotions suppress the secretion of milk and change its chemical composition. If this assumption is true, the graphic record should show a fall in milk production as intense emotions are indicated and a rise as milder emotions are evidenced, and marked variations in emotional reaction should be accompanied by changes in composition of the milk greater than the usual daily variation. An analysis of a sufficient number of such records over long periods of time should substantiate or refute theories which claim a relationship between variations of emotion and quantity and quality of milk produced. Chemical and biological studies are now in progress which will provide data for the correlation of the physiological and psychological findings.

PHYSIOLOGICAL STUDIES

The long-time psychological observations have been accompanied by comprehensive physiological studies made simultaneously on the same subjects. Physicians on the medical staff of the Woman's Hospital of Detroit examined and approved the health status of the women under investigation before the studies were begun. The family physicians have since coöperated continuously in making available all office records of the health and treatment of the women and in reporting any information that they believed to be pertinent to the studies in progress. The worker visited the physicians with the women if medical advice was sought during her visit in the home.

During the 2 lactation periods and 1 pregnancy period the women have been weighed weekly under specific conditions; their basal metabolic rates determined twice; detailed oral examination and roentgenograms of the teeth recorded at definite intervals in the reproductive cycle; and their bodily measurements and photographs taken as guides in determining their body constitutions and body types. The maternal food intake has been studied qualitatively and quantitatively in the homes. The constituents of the in-

dividual diets have been computed from accepted tables showing the composition of food materials, and the diets chemically analyzed at various intervals.

Detailed analytical studies have been made of the chemical variability of the milk of the individual women at definite intervals throughout the progression of lactation, to ascertain the quality and quantity of milk received by the infant during the process of growth and development. These determinations have included the analysis of all the milk secreted at hourly intervals throughout the day and night over a specific period of time. These studies will yield information upon the chemical composition of hourly, daily, and monthly samples of milk from the same individuals during two successive lactation periods, and upon the relative amounts of milk secreted by the right and left breasts and the relative composition of milk at the first half and last half of nursing. Biological assay of the vitamin A and B contents of the individual milks in 2 lactation cycles, comprehensive chemical analyses of the urine during pregnancy and lactation, and periodic blood chemistry studies have been made.

Periodic chemical metabolic balance studies have been made in order to observe the ability of the maternal organism to utilize the food consumed for satisfying the many demands placed upon her during the reproductive cycle, i.e., in maintaining her own physical well-being, in assuring optimal conditions for the development of the fetus in utero, and in preparing her own body tissues for the elaboration of milk to feed the infant. This information can be obtained only through studying the differences between the chemically determined constituents of the total food and liquid intakes and the total outgo of urine and feces during pregnancy, and between the total food and liquid intakes and the total outgo of urine, feces, and breast milk during lactation. These chemical metabolic balance studies have extended over five- and ten-day periods in the homes at specific intervals during the 2 lactation periods and 1 pregnancy period, during which periods the materials used for the chemical assay were collected.

The development of the infants has been followed in detail. Records of the prenatal, birth, and feeding histories, roentgenograms of the long bones for the detection of rachitic tendencies, and the course of the mental and physical development, all of which should contribute valuable data in this coördinated research, have been secured.

The data obtained in these psychological and physiological studies should furnish a basis for the further interpretation of psychophysiological relationships.

DISCUSSION

Medical literature carries the opinion that fatigue, excessive activity, and intense emotions have deleterious effects upon human milk secretion. This conception is not, however, based upon scientifically recorded observations but upon general clinical experience. The method presented herein offers an opportunity for studying the physiological manifestations of intense emotion, and the effects of fatigue in

relation to emotional reactions and milk secretion.

A graphic illustration of the method of coördinating psychological and physiological data is presented in Plate III, where the volume output of milk is studied in relation to emotional reactions. This method of recording data provides for an interpretation of widely diverse types of material. It is the purpose of this paper, however, to present a method for integrating data of various types, rather than a summary of findings with respect to the data used.

Observations have been made on the hours of rest and sleep in relation to the degree of activity. The method includes also the differential rating of the "tired-rested" and "energetic-listless" reactions, the comparative trend of the ratings made in the afternoon and evenings, and the comparative ratings of emotion reactions, such as fear, anger, joy, love, worry, and excitement, all of which are recorded simultaneously and all of which can be compared with physiological reactions. Any relationship between fatigue or emotion and the volume output of the chemical composition of the milk secreted by a woman can be noted, and the findings obtained in the chemical analysis of the blood and urine can be coördinated with the other factors rated.

The graphic representation of the quantitative psychological and physiological findings may yield information concerning certain mind-body relationships. For example, if intense emotion does affect the secretion of milk and vary its composition beyond the usual limits of variability for a given individual within a given stage of lactation, any appreciable fluctuation will be evident in the graphic record over an extended period of time. Such a variation must, of course, be in contrast to the usual emotional and physiological findings recorded. In other words, it is necessary to know the accustomed variability in the psychological, physiological, and biochemical reactions as a basis for interpreting results obtained during a period of intense emotion, or of other unusual variation.

These studies of the factors influencing human milk secretion offer a practical and successful demonstration of a technique employed in securing and evaluating quantitatively coördinated psychological, sociological and physiological data centered upon an individual within the family group.

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Inter-relationships in the Behavior of Young Children

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THE following series of reports presents results from a coöperative experiment carried out by a group of graduate students in the University of Minnesota Institute of child welfare during the fall of 1928. The major purpose of the experiment was to develop a method whereby direct observations of specified modes of behavior might be reduced to quantitative expression on a uniformly graduated scale, and to ascertain their inter-correlations with each other and with such additional measures as might be available through other sources.

The traits selected for observation were as follows: physical activity (2 observers), amount of conversation or talkativeness (2 observers), laughter (3 observers), compliance (4 observers) and social traits including both social participation and leadership (2 observers). Thirty-three nursery school children, 17 boys and 16 girls, whose ages taken at the middle of the observational period ranged from 27 to 59 months were used as subjects. The mental age range was from 30 to 75 months with mean of 48.8 months; the I.Q. range from 77 to 170 with mean of 110.5.

In securing the original observational material the method of short samples (1) was used. Each observer secured a total of 25 one-minute observations of each subject. Each observation was taken on a different day[1] and no two persons observed a child at the same time, so that all measures were taken independently of each other. This method insures that factors incident to the immediate situation but not pertinent to the general field of inquiry will not operate to give a spurious appearance of reliability to the data; in other words, that errors of measurement will be uncorrelated.

The general procedure which was carried out by all groups was as follows: After having decided upon the particular aspect of behavior to be observed, a series of descriptive categories was built up in such a way as to form roughly graded steps from a low to a high degree of the trait in question. This preliminary scale was then tried out empirically by having the members of the group make simultaneous obser-

[1] In a small number of instances it was necessary to make two observations of a child on the same day in order to make up for losses due to absences. When this was done the two observations were always separated by as great a time interval as possible. As a rule, one was taken in the morning, the other in the afternoon. In this respect the procedure differed from that used by W. C. Olson (5).

vations on each of a number of children, classify their behavior independently and then compare the results. In most instances these first try-outs revealed inadequacies in the formal descriptions which led to disagreement in classification. When this was found to be the case, the scales were revised or the phraseology clarified and the method retested for objectivity in the same manner. This process was continued until it was found that exact agreement in classification was obtained in at least 95 per cent of the independent observations, with no disagreement greater in amount than one step on the scale. When the above degree of precision had been reached, work on the main project was begun.

So far as possible, observations were made during the free-play hours from 9:30 to 10:30 in the morning and 2:30 to 4:00 in the afternoon. In a few cases, owing to conflicts in the students' programs, these hours could not be used. The effect of such irregularities upon the consistency of the results will be discussed in connection with the papers on laughter and talkativeness.

All records were made on prepared mimeographed forms so arranged as to reduce the labor of recording to a minimum. A sample of the form used is shown in figure 1.

In the space following the words *Observation of* _____

Observation of.....

Date.....Day.....Hour.....Observer.....

Notes.....

.....

CHILDREN	ORDER OF OBSERVATION	PLACE	OCCUPATION	SCORES (IN 15 SECOND INTERVALS)			
				1	2	3	4
A—— R—— Others							
A—— J—— Others							

FIG. 1

the kind of behavior under observation (as laughter, physical activity, etc.) was recorded. The names of the children, arranged in alphabetical order were mimeographed on the sheets in order to economize time in record taking. The second column, headed *Order of Observation* provided a space for checking the order in which the different children were observed. This order was varied systematically from day to day, since it was thought possible that certain forms of behavior

might show constant variational trends from beginning to end of the hour.[2]

The place of observation (playground, gymnasium, or room number) was recorded in the third column, followed by a note as to the child's occupation at the time. In the last four columns the child's behavior score was recorded at fifteen-second intervals during the minute of observation. Recording was done by means of symbols representing the various steps or categories in the scales used. Each observer, therefore, obtained 100 separate records for each child in the course of the 25 observations. The names of other children in the group with the child were also recorded for use in another study.

After the data had been collected, the results for all the children were pooled and scale values for the separate categories were obtained by the use of the formula.

$$d = \frac{z_1 - z_2}{q_1 - q_2}$$

where q_1 and q_2 are the proportions of the total number of observations lying beyond the upper and lower limits respectively of the category involved, and z_1 and z_2 are the ordinates for these proportions. (3) An arbitrary zero point of 3 sigma below the mean was assumed as the point of origin in all cases, so as to do away with negative values. Scores for each child were then computed by multiplying the frequency-score in each category by the scale value of that category, summing, and dividing the result by the total number of observations.

Individual scores were obtained upon the basis of the records of each observer separately, and also for the combined records of all observers for a given trait. The reliability of the scores was then computed by finding the mean inter-correlations between the scores of the separate observers for each trait and correcting by the Spearman-Brown prophecy formula.[3] This method may properly be regarded as a rather rigorous test of reliability, since it is based upon the extent of agreement between the records of different observers working at different times, and upon brief samples of behavior taken on twenty-five or more different days during a period of eight to ten weeks.[4] Under these circumstances, the extent to which a child maintains his position in the group may fairly be taken as an index to his habitual behavior in the nursery-school situation at the period of development under consideration.

After the series of observations had been completed, the following additional material was obtained for purposes of correlation.

1. Each observer ranked the 33 subjects in order of *physical beauty*. The ranking was done by a modified form

[2] For example, one student observed talkativeness during the lunch hour. It is not improbable that as the appetites of the children become satisfied, definite changes in the amount of conversation take place.

[3] The applicability of the prophecy formula to material of this kind had previously been demonstrated by Parten in her Ph.D. thesis (as yet unpublished).

[4] Since the members of each group made their observations on different days as far as was practicable, the actual number of days included in each series of observations is considerably in excess of twenty-five for all subjects.

TABLE 1

Intercorrelations of mental, social, and physical traits in nursery school children

	LAUGHTER	COMPLIANCE	SOCIALITY	LEADERSHIP	PHYSICAL ACTIVITY	TALKATIVENESS	BEAUTY	ATTRACTIVENESS OF PERSONALITY	MARSTON SCALE	OLSON SCALE	CHRONOLOGICAL AGE	MINNESOTA M.A.	MINNESOTA I.Q.	MERRILL-PALMER M.A.	MERRILL-PALMER I.Q.	HEIGHT	WEIGHT	LENGTH OF NURSERY-SCHOOL ATTENDANCE
Laughter	+.83 +.73	{.36 .27	{.34 .52	+.53	+.28	+.38	+.34	+.35	+.38	{.57 .43	+.45	+.41	+.07	+.40	+.13	+.35	+.23	+.48
Compliance	η	+.47 +.55	{.32 .36	.17 .30	−.37	−.33	+.19	−.10	−.20	−.11	−.31	−.34	−.15	−.35	−.27	−.31	−.13	−.40
Sociality	η	η	+.76 +.41	+.98	+.31	+.59	−.14	+.09	+.45	−.19	+.74	{.74 .83	+.08	{.72 .62	+.35	+.74	+.52	+.56
Leadership	+.33	η	+.96	+.76 +.45	+.29	+.61	−.20	+.17	+.46	−.29	+.71	+.64	+.10	+.66	+.36	+.71	+.52	+.58
Physical activity	+.17	−.31	+.15	+.13	+.86 +.85	+.25	+.06	+.17	+.28	+.17	+.29	+.21	−.07	+.29	+.11	+.26	+.18	+.24
Talkativeness	+.27	−.25	+.53	+.55	+.17	+.59 +.53	+.42	+.38	+.60	−.46	+.35	+.49	+.32	+.46	+.35	+.[illegible]	+.29	{65 .44
Beauty	+.40	+.21	−.24	−.31	+.05	+.46	+.91 +.91	−.08	+.36	−.57	−.03	+.19	+.29	+.25	+.41	+.01	+.04	+.26
Attractiveness of personality	+.48	−.17	+.34	+.43	+.24	+.48	−.08	+.95 +.95	+.40	−.76	−.18	+.16	+.23	+.15	+.42	−.15	−.14	+.18
Marston scale	+.40	−.19	+.60	+.59	+.27	+.62	+.36	+.42	+.98 +.98	−.12	+.06	+.14	+.03	+.16	+.20	+.11	+.06	+.29
Olson scale	η	−.09	−.18	−.32	+.21	−.46	−.58	−.80	−.12	+.94 +.94	−.09	−.41	−.32	−.34	−.29	−.13	−.10	−.20
Chronological age	−	−	−	−	−	−	−	−	−	−	− −	+.78	+.00	+.85	+.24	+.85	+.59	+.68

Minnesota M.A.	+.11	−.17	η	+.20	−.03	+.37	+.34	+.49	+.15	−.55	—	—	+.61	+.90	+.64	+.74	+.44	+.73
												—						
Minnesota I.Q.	—	—	—	—	—	—	—	—	—	—	—	—	—	+.35	+.67	+.13	−.05	+.30
													—					
Merrill-Palmer M.A.	+.23	−.17	η	+.15	+.09	+.33	+.52	+.58	+.21	−.50	—	+.72	—	—	+.68	+.73	+.46	+.74
														—				
Merrill-Palmer I.Q.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+.28	+.05	+.46
															—			
Height	−.07	−.09	+.31	+.29	+.03	+.39	+.07	+.01	+.11	−.10	—	+.23	—	+.03	—	—	+.77	+.63
																—		
Weight	−.05	+.07	+.15	+.18	+.01	+.11	+.07	−.04	+.03	−.06	—	−.04	—	−.10	—	+.55	—	+.48
																	—	
Length of nursery-school attendance	+.26	−.27	+.12	+.15	+.05	η	+.38	+.42	+.34	−.19	—	+.44	—	+.42	—	+.13	+.13	—
																		—

The first of the paired numbers within each boxed space is the reliability coefficient as computed for the entire group of cases; the second is the reliability coefficient when age is held constant by partial correlation. The reliability of the mental tests and of the two physical measurements is known to be high; but as these values have not been separately established for this particular group of cases precise figures cannot be given.

The values above the diagonal row of reliability coefficients are the intercorrelations of zero order; those below the diagonals are the first-order intercorrelations when age is partialled out. Coefficients enclosed in braces are correlation ratios.

of the method of paired comparisons. Each child's name was written on a separate slip of paper, and the slips were then arranged in order by comparing in turn each one with every other one.

2. Ratings of each child on *attractiveness of personality* by the method of absolute judgment were also made by each observer. A five-point rating scale was used with steps defined as follows:

a. Very delightful personality. Attracts and holds the frienship of others. Liked by both children and adults. His companionship is universally sought for.

b. Pleasing personality. Liked by most of the persons with whom he comes into contact.

c. Rather colorless personality. In general is neither greatly liked nor disliked. His companionship is neither sought nor avoided.

d. Rather unattractive personality. A few friends but not generally popular.

e. Decidedly unattractive personality. Disliked and avoided.

3–4. A copy of the Marston rating scale for introversion-extroversion, (4) and of the Olson series of ratings for the prediction of behavior problems,[5] was filled out for each child by each observer.

Data were also obtained from the nursery-school records, as follows: (1) Chronological age taken as at the midpoint of the period of observation, (2) sex, (3) mental age on the Minnesota test for pre-school children corrected to agree with chronological age at above date, (4) I.Q. on above test, (5) mental age on the Merrill-Palmer series of performance tests, (6) I.Q. on Merrill-Palmer test, (7) standing height and (8) weight, both as of above date, (9) hemoglobin test, (10) number of days' attendance at nursery school, (11) occupational status of father, (12) size of family, (13) birth order, and (14) a rating on general physical condition (excellent, good, fair or poor) given by the nursery-school pediatrician.

In order to avoid unnecessary repetition, the intercorrelations of the observational findings with each other and with the rating scale, intelligence test results, measurements of height and weight, and attendance record are presented in collective form at this point (see table 1). Their discussion is reserved for the separate reports which follow. No reliable correlations were found between either the hemoglobin test or the physician's ratings on health and any of the other variables, hence these have not been included in the table. These children, it must be remembered, were all in good health and none of the hemoglobin scores were below the standard commonly accepted as normal. Differences associated with sex and occupational class are few, and will be discussed in connection with the traits in which they occur. Size of family and birth-order appear to be unrelated to the other factors considered in this study.

PHYSICAL ACTIVITY[6]

Method. The method used in this investigation has been explained in the

[5] Unpublished Ph.D. thesis, University of Minnesota.

[6] The observations on physical activity were made by Miss Genevieve Hobart and

foregoing section. Two graduate students made the observations, using the following categories.

0. No observable activity
1. Hand and arm movements only
   a. Active
   b. Strenuous
2. Hand, arm, and trunk movements only
   a. Active
   b. Strenuous
3. Leg and trunk movements only
   a. Active
   b. Strenuous
4. Movements of the whole body
   a. Active
   b. Strenuous

"Strenuous" activity included rapid movements, or movements in which considerable energy was utilized such as sliding, rapid running, climbing stairs or ladders, lifting heavy objects, supporting the body by the hands, crawling and hanging stunts, and the like. Less energetic movements were called "active." At the end of each fifteen-second period during the minute of observation, the observer recorded the child's behavior during that time by writing the appropriate number and letter in the columns provided for that purpose.

Reliability. The average inter-correlation between the two observers was .76 and this became .86 when it was corrected by the Spearman-Brown formula. Since one student observed almost entirely between the hours of 9:30 and 10:30 in the morning, while the other nearly always made her observations between 2:30 and 4:00 in the afternoon, this figure is probably somewhat lower than would have been found if the hour of observation had been uniform. The reliability with age held constant was .85. The standard deviation of the distribution was .26.

Relationship between physical activity and other factors. Insofar as the methods employed have yielded valid measures of the forms of behavior under consideration, physical activity seems to be but slightly related to other characteristics of the children in this group. None of the correlation coefficients were as much as four times their probable error; the greater number were less than twice their probable error. The highest relationship found was a negative correlation of $-.37 \pm .10$ with *compliance.* This drops to $-.31$ when age is held constant. While this finding needs to be confirmed by study of a larger number of cases, it is quite in line with the common observation that children who are most active physically are likely to be somewhat less docile than those who are more quiet. One might hazard the assumption that such a relationship, if it exists, is largely the result of the fact that the more active children are more often engaged in some definite occupation of their own, and on this account are less ready to comply with the requests and suggestions of others than children who are more frequently unoccupied. Other correlations with physical activity which may possibly be suggestive are as follows: with sociality, $+.31$; leadership, $+.29$; extroversion, $+.28$; attractiveness of personality as judged by adults, $+.24$; likelihood of becoming a behavior problem (Olson scale), $+.21$; frequency of laughter, $+.28$.

Mrs. Jean Helgeson. Mr. Robert Challman is responsible for the statistical work and for writing this section of the paper.

Although these correlations are low, they are in the expected direction.

TABLE 2

Effect of sex upon physical activity

SEX	N	M	σ	D	D/σd
Boys	17	3.12	.26	.24	3.00
Girls	16	2.88	.19		

When age is held constant, the correlations between activity and intelligence as measured either by the Minnesota or the Merrill-Palmer tests, length of attendance at the nursery-school, beauty as rated by twelve judges, height, weight, size of family, position among siblings, social status as indicated by occupation of father, and a physician's rating on general health are all lower than their probable errors.

Support for the common belief that boys are more active than girls is, however, found in this study. The boys' mean for physical activity was 3.12, the girls' mean was 2.88. This is a significant difference as table 2 shows.

There is also a differential effect of age upon physical activity when sex groups are used. Disregarding sex, the correlation between C.A. and physical activity is +.29 but when the sexes are separated into age groups it is found that the mean physical activity score (3.22) for the older boys (45–57 months) is considerably greater than the mean (2.98) for the younger boys (27–45 months). Although this difference is only 1.8 the standard error of the difference, it is much larger than the difference between the girls' groups of similar age which is only .03. Also the difference in activity between the younger boys and girls is compara-

TABLE 3

Effect of sex and age upon physical activity: Age differences between boys, and age differences between girls in physical activity

SEX	AGE						D	D/σd
	27–45 months			45–57 months				
	N	M	σ	N	M	σ		
Boys	7	2.98	.34	10	3.22	.11	.24	1.8
Girls	9	2.87	.17	7	2.90	.21	.03	.31

TABLE 4

Effect of sex and age upon physical activity: Differences in physical activity between boys and girls of the same age

AGE	SEX	N	M	σ	SEX	N	M	σ	D	D/σd
months										
27–45	Boys	7	2.98	.34	Girls	9	2.87	.17	.11	.78
45–57	Boys	10	3.22	.11	Girls	7	2.90	.21	.32	3.56

tively slight, but for the older boys and girls it is very well marked, the difference being 3.56 times the standard error of the difference. Therefore it would seem probable that young boys are only slightly more active than girls of the same age, but that they increase in physical activity markedly as they grow older, while girls start on a lower level of activity and do not become more active as their age increases. The results are shown in tabular form in tables 3 and 4.

TALKATIVENESS[7]

Method. In the outset of the study it was hoped that a qualitative as well as a quantitative measure of the children's conversation could be secured. It was found, however, that a one-minute sample did not insure enough acquaintance with the general setting to make this practicable. Moreover, so much of the conversation of the younger children was difficult to understand unless the observer stood so close as to run the risk of interfering with the nursery-school activities, that it was deemed better to abandon the qualitative aspect of the study entirely and to confine attention to the amount of verbal activity without regard to its nature or quality.

Five levels of verbal bahavior or its equivalent were distinguished. Each of these levels was then further divided according to whether the speech or speech-substitute was initiated by the child himself or occurred in response to overt stimulation from a teacher or playmate. The resultant categories were as follows:

[7] This section of the report was done by Ruby Glockler and Eunice Matheson.

1. O_r—Failure to respond to a definite verbal stimulus, as to a question or request.

2. O_i—Silence when no stimulus was given, i.e., no attempt to initiate conversation.

3. B_r—Bodily response without verbal accompaniment when a definite stimulus is given, as a nod or shake of the head in answer to a question, approaching other person in response to request, etc.

4. B_i—Spontaneous initiation of motion or gesture which clearly is intended as a substitute for the spoken word, as beckoning with hand, etc.

5. V_r—Incomprehensible vocalization or babbling in response to stimulation, as when a child utters an unverbalized "grunt" of objection when another child threatens to encroach upon his place at the sand-pile.

6 V_i—Unverbalized sounds initiated by the child without apparent stimulus.

7. S_r—Single-word responses, including short phrases which are ordinarily learned as units, such as "yes," "all right," "good morning," etc.

8. S_i—Single-word remarks initiated by the child.

9. M_r—Responses involving more than one word. This includes both phrases and sentences, either long or short, also repetitions of single words when joined in a continuous series, as "No, no, no."

10. M_i—Initiation of conversation by the child when groups of more than one word are used.

Reliability of scores. The correlation between the score of the two observers was +.42 which becomes +.59 for the combined series according to

the Spearman-Brown formula. The low reliability is probably a function of the different hours used for observation. The records of Observer G were taken entirely during the lunch hour; those of M during the morning free-play hour. Differences in reaction toward food, in the composition of the groups at the various tables,[8] and similar factors undoubtedly play some part in determining the amount of conversation during lunch. On the other hand, the lunch hour affords the advantages of a relatively fixed situation in which the children are brought face to face with each other in a way which possibly facilitates conversation to a greater extent than do the more variable situations of the free-play hour. It is difficult to say which of the two circumstances affords a better opportunity for securing a valid measurement of talkativeness in general, but the following crude test is at least suggestive.

Two of the items (Nos. 2 and 18) on the Marston scale for introversion-extroversion deal directly with the matter of talkativeness. These items are described as in the tabulation below.

INDICATING EXTROVERSION	INDICATING INTROVERSION
Item 2	
Eager to express himself before a group. Likes to be heard.	Avoids talking before a group. When obliged to talk before a group finds it difficult.
Item 18	
Frank, talkative and sociable, does not stand on ceremony.	Secretive, seclusive, and "shut in," not inclined to talk unless spoken to.

[8] Lunch is served at small tables with a teacher in charge of each. From three to five children sit at each table.

The reliability of the summed ratings on these two items given by 10 observers not including G and M was found to be +.85. When G's observational scores alone were compared with the sum of the ratings of the 10 judges on the two items the correlation was found to be +.71; while M's observations correlated with the summed ratings only to the extent of +.36. Since none of these 10 judges had used the luncheon hour for making their observations of the children, and all except 2 had observed at the same hour as had M, the higher correlation of their ratings with G's scores suggests that the constant situation during the lunch-hour, with the general stimulus to conversation afforded by the face to face position, more than makes up for any possible variant factors such as appetite. An attempt was made to estimate the effect of appetite upon talkativeness at the table by comparing G's scores with ratings on apparent appetite which were given by the teachers in charge of the tables. While only small differences were found, these tended to follow the pattern which might be expected, in that the children with "average" appetites were somewhat more talkative than either those whose appetites seemed to be unusually keen, or those whose appetites were small or who sometimes refused food.

Relationship of talkativeness to other factors. In spite of the low reliability of the talkativeness scores, their relationship to other factors considered in this study is higher than was found for physical activity. The highest correlations are with leadership, where $r = +.61$ (age constant, $+.55$), with extroversion, $r = +.60$ (age constant, $+.62$), and with sociality, $r = +.59$ (age constant $+.53$). With number of days' attendance at the nursery-school there is a suggestion of a curvilinear relationship $\eta_{xy} = +.65$; $\eta_{yx} = +.44$; when corrected for small number of cases and consequent coarse grouping. Inspection of the regression lines suggests that increased length of nursery-school attendance makes for increased talkativeness in the nursery-school situation during the first few months, but that thereafter little further change takes place. It is probable that this is the result of two factors, age and acquaintanceship. Since most of the children enter the nursery-school at about the age of two years, the first few months of attendance would coincide with the period of most rapid development in language ability. Moreover, as the child becomes better adjusted to the nursery-school situation, and more thoroughly acquainted with his playmates he is likely to carry on more conversation with them than while they were comparative strangers. That the factor of acquaintance is more important than that of age is suggested by the fact that little or no corresponding curvilinearity is observed in the regression of talkativeness on age, while the correlation between age and talkativeness is only $+.35$. Correlations between talkativeness and mental age are somewhat higher: $+.49$ for the Minnesota test and $+46$ for the Merrill-Palmer. With I.Q. on the Minnesota test, the correlation is $+32$; with I.Q. on the Merrill-Palmer, $+.35$. With height, the correlation is $+.49$ ($+.39$ with age constant), with weight, $+.29$ (age constant, $+.11$). Talkativeness and beauty correlate to the extent of $+.42$ (age constant, $+.46$); talkativeness and laughter, $+.38$ (age constant $+.27$); talkativeness and attractiveness of personality, $+.38$ (age constant $+.48$). There is a negative correlation of $-.46$ when age is held constant between talkativeness and probability of becoming a behavior problem according to the combined ratings on the Olson scale.

TABLE 5

Differences in talkativeness between children of different occupational classes[9]

	N	MEAN SCORE	σdis	DIFFERENCE	σdiff	Diff/σd
1. Classes I–II	11	3.12	0.14	(1–2) 0.14	0.06	2.33
2. Class III	12	2.98	0.17	(2–3) 0.08	0.10	0.80
3. Classes IV–V	10	2.90	0.28	(1–3) 0.22	0.10	2.20

No sex differences in talkativeness

[9] Classes I to II include the professional, semi-professional and managerial groups; Class III, clerical, skilled trades and retail business groups, Classes IV to V, semi-skilled, and slightly skilled groups. Group VI, which is made up of day-laborers was not represented in the nursery-school at the time this study was made. See Goodenough (2).

are apparent for this group. Differences between social classes as indicated by paternal occupation are, however, fairly well defined, as shown in table 5.

There is a progressive decrease in the talkativeness scores as we go down the scale of occupational classes. Only 20 per cent of the children in Classes IV to V equal or exceed the median child in Classes I to II in talkativeness. Within this group, talkativeness appears to bear no significant relationship to size of family, position of child among siblings, or to health as indicated either by the hemoglobin test or by the physician's ratings.

COMPLIANCE[10]

Method. The problem of developing objective categories for classifying behavior with regard to compliance or non-compliance proved to be an exceedingly difficult one. Several preliminary scales were tried out for objectivity before one was devised which would meet the requirement of at least 95 per cent agreement among simultaneous observers. Although the final scale showed 97 per cent agreement for 38 cases with from two to four observers for each, other difficulties arose as will be shown later.

The descriptive categories as finally agreed upon were as follows:

1. O—No stimulus, i.e., no request or suggestion made to child during period.
2. A_1—Accepts without hesitation or resistance.
3. A_2—Accepts after brief hesitation and without urging.
4. A_3—Accepts after urging or reminding. Offers no overt resistance.
5. A_4—Accepts after having previously refused. (Verbal resistance.)
6. A_5—Accepts after bodily resistance.
7. A_6—Accepts after both verbal and bodily resistance.
8. R_1—Does not accept. Hesitates, delays or ignores suggestion.
9. R_2—Verbal or vocal resistance. Does not accept.
10. R_3—Bodily resistance. Does not accept.
11. R_4—Both vocal and bodily resistance. Does not accept.

Scores were combined by the method previously described, except that only those cases were used in which there occurred a stimulus to compliance, in the form of a verbal request or suggestion. Since such stimuli were found to occur in only 10.4 per cent of the observational periods, approximately 90 per cent of the observers' time was wasted, so far as getting usable data for this study is concerned. It thus came about that although there were four observers for this part of the study, the combined number of usable records obtained by them was only one-fifth as great as in the studies having only two observers, but in which all the records were significant. A second point of difficulty had to do with arranging the categories in rank-order from most compliant to least compliant. Obviously, in order to secure an adequate measure of compliant or non-compliant behavior in any individual instance a quantitative knowledge of the following factors, and

[10] This portion of the study was made by Frances Jones, Barbara Marx, Robert Challman, and Helen Sundberg.

possibly others as well, should be available: (1) attractiveness of the request or suggestion for the child (2) amount of pressure brought to bear in order to secure compliance. In the absence of such information, a tentative order of arrangement based upon the combined estimates of the entire group of observers was agreed upon as foliows: A_1, A_2, R_1, A_3, A_4, R_2, A_5, R_3, A_6, R_4. Data to verify the correctness of this arrangement are wanting.

The following summary shows the relative frequency of the various levels of compliance or non-compliance for this group of cases.

Percentage of time compliance was shown within one minute

Without hesitation or resistance..	42.2
After brief hesitation without urging.....	11.3
After urging or reminding without resistance.....	4.5
After having previously refused...	1.6
After bodily resistance.....	1.5
After bodily and verbal resistance.	0.5
Total compliance within one minute.....	63.2

Percentage of non-compliance

Hesitates, delays or ignores.....	15.9
Verbal or vocal resistance.....	12.4
Bodily resistance.....	4.9
Both vocal and bodily resistance..	5.0
Total non-compliance.....	37.8

Percentage of time bodily resistance was shown

Bodily resistance.....	6.4
Bodily resistance accompanied by verbal resistance.....	5.5
Total bodily resistance.....	11.9

From these tables it can be seen that immediate compliance occurs in 4 out of 10 requests, and that in roughly 60 per cent of the cases, the nursery-school children comply with requests within one minute. These requests are not only from the teachers, however, but also from the other children, a fact that might lead one to expect even a higher percentage, if suggestions were proffered by adults only. It can be seen also that these children offer some degree of bodily resistance in a little better than 10 per cent of all instances.

Reliability of scores. The average intercorrelation between the 4 observers was +.18, which becomes +.47 when corrected by the Spearman-Brown formula. The low reliability may fairly be attributed to the small number of effective observations, rather than to greater inaccuracy in classification or to greater inconsistency in the children's behavior than was present for the other traits studied. Had a request or suggestion been made to each child in each observational period so that all the observations could have been used, the expected reliability according to the prophecy formula would have been +.90 for 4 observers or +.82 for 2 observers. It is evident that the ordinary nursery-school routine does not provide adequate opportunity for the observation of behavior of this kind except at the cost of a considerable expenditure of time. Possibly a formal laboratory test might serve the purpose better, although it should be noted that in the study carried out by Reynolds (6) in which the test-method was employed the obtained reliability was only +.46.

Relationship of compliance to other factors. All the intercorrelations are so low that little reliance can be placed upon them. If we should adopt the very lenient viewpoint that correla-

tions between .2 and .4, which, with the number of cases involved, means roughly from two to four times the probable error may possibly suggest trends, we find some indication of a small positive relationship between compliance and the following traits: sociality, leadership, and beauty; and of a small negative relationship with laughter, physical activity, talkativeness, extroversion, chronological age, mental age on both the Minnesota and the Merrill-Palmer tests, and length of nursery-school attendance.

LAUGHTER[11]

Method. The general procedure was the same as that outlined under the foregoing studies. There were 3 observers, 2 of whom made their observations during the free-play hour in the morning while those of the third were divided between the afternoon free-play hour and the morning hour devoted to stories and rhythms. Eight descriptive categories were used for recording the behavior, but because of the very small number of frequencies falling under the first three heads, these were later combined in the statistical treatment. The categories with their definitions follow:

C—Crying. Audible crying accompanied by tears.

W—Whimpering. A low broken whining, not accompanied by tears.

P—Pouting or frowning. A protrusion of the lips in ill-humor; a knitting of the brow in displeasure.

So—Sober. A calm unemotional expression, whether talking or not.

Sm—Smiling. A pleased or amused expression, characterized by a lateral upward extension of the lips.

L_1—Brief laughter. Not more than two spasmodic expulsions of breath with jerky sounds accompanied by movement of the facial muscles.

L_2—Prolonged laughter. More than two spasmodic expulsions of breath as above described.

L_3—Shouting laughter. Loud and boisterous laughter.

Reliability of scores. The correlation between the scores of the 2 obseovers who made their records at the same hour of the day was +.77; while the correlations between their scores and those of the third observer were +.61, and +.47 respectively. Again, the differential effect of a change in the situation upon the behavior of individual children is evidenced. The average intercorrelation for the 3 observers is +.61, which becomes +.83 when corrected by the Spearman-Brown prophecy formula.

Relationship of laughter to other factors. Perhaps the most interesting result obtained from a study of the table of intercorrelations with frequency of laughter is to be found in a group of curvilinear relationships which, taken collectively, afford some evidence that the optimum position with respect to laughter lies at about the mid-point of the distribution rather than at either extreme. These may be summarized as follows: The children who laugh an average amount tend to exceed those whose laughter is either excessive or deficient (in comparison with the remainder of the group) in sociality (η_{xy} = +.34, η_{yx} = .52); they are somewhat less likely to be

[11] The study of laughter was made by Josephine Conger, Cornelia Taylor and Ruby Friend.

regarded as behavior problems, (η_{xy} = .43, η_{yx} = .57); and are slightly more compliant to the wishes of others, (η_{xy} = .36, η_{yx} = .27). All these correlations have been corrected for coarse grouping due to the small number of cases. Little or no tendency toward curvilinearity is, however, apparent in the correlation between laughter and leadership, where r = +.53, age constant, +.33; or with talkativeness, r = +.38; age constant, +.27; beauty, +.34, age constant, 40; attractiveness of personality, r = +.35, age constant, +.48; extroversion, r = +.38, age constant, +40; chronological age, r = +.45; and length of nursery-school attendance, r = +.48, age constant, +.26. With age constant, the correlations between laughter and intelligence as measured either by the Minnesota or the Merrill-Palmer test, between laughter and height, weight, and health ratings were all less than twice the probable error. Likewise, no sex differences and no differences associated either with size of family, position among siblings or paternal occupation were apparent in this group.

SOCIAL TRAITS[12]

Method. The observers for this study endeavored to distinguish between and to make separate records of two aspects of social behavior, a quantitative aspect which may be labelled "social participation," and a qualitative aspect denoting various levels of leadership. The results, however, show such a high degree of correlation between the two series of scores as to render it evident that either social participation and leadership are fundamentally similar, or that the descriptive categories have failed to make adequate distinction between them. It is believed that the second hypothesis is at least partially true, and furthermore that the fault lies with the definitions used for the so-called "leadership" series rather than with those used for social participation. If this is correct, the findings for social participation are the more significant. However, the results from both series will be reported.

The categories used, with their definitions, are as follows:

I. For social participation:

A. Solitary unoccupied. A child who is not in close proximity with any group and is not in conversation with any other child. Doing nothing.

B. Solitary occupied. A child who plays by himself. There is no conversation with other children, and he pays no attention to other children.

C. Parallel activity. This is the simplest type of group formation. Each child is in close proximity with other members of group, and all are engaged in the same or similar occupations, with or without an occasional observation from one member of the group to another but there is *no* conversa-

[12] Bertha B. Hayes and Jean Wilcox were the observers in this study and are authors of this section.

tion between members of the group. Each individual child's activity is a unit.

D. Simple coöperative activity. The members of the group are engaged in the same or allied occupations and there is conversation between members of the group. Each child's activity may be modified by others in the group through observation and imitation, and yet each child's activity is a unit. There may be taking of turns.

E. Organized coöperative activity. There is an assignment and differentiation of parts among members of the group. Each child contributes his or her part to the activity of the group, and here the group rather than the individual child is the unit.

II. For leadership:

1. Interfered with. The child who is or is not engaged in some activity has been interfered with by one or more children.
2. Interferer. The child who initiates an interference with a single child or with a group of children. This is not classed as an occupation in itself.
3. Rebel. The child is rebelling against the interference or coercion of one or more children but does not initiate the interference or coercion himself.
4. Observer. A child whose interest is in the group as shown objectively by observation and who is in close proximity with the group but is not a participant.
5. Participant. One who is participating actively with the group, or who is a follower or imitator in the group activity.
6. Unsuccessful leader. A child who is opposed in an attempted coercion by one or more members of the group.
7. Successful leader through force or trickery. A child who dominates other children of the group against their will.
8. Successful leader through persuasion or personality. The child who is being imitated in his activity or who is able to persuade other children to follow him or to control their activities.

Reliability of the scores. For both sociality and leadership the correlation between the scores of the 2 observers was +.61, which becomes +.76 when corrected by the Spearman-Brown formula. The correlation between the combined scores of the 2 observers on sociality and leadership is +.98; with age constant, +.96. The fact that the correlation between the two supposedly dissimilar traits is so much

higher than the reliability of either can hardly be explained on any other basis than that the 2 series of records really measured the same thing to a very great extent. Since both records were made on the same occasions, the day-to-day fluctuations of behavior which have operated to lower the reliability coefficients would not appreciably affect the correlations between the two traits.

Relationship between social traits and other factors. Correlations with the other observational scores have already been mentioned. When age is held constant, the correlation between sociality and extroversion is +.60; between leadership and extroversion is +.59. Correlations with chronological age are +.74 for sociality and +.71 for leadership. Attractiveness of personality correlates with sociality to the extent of +.34 and with leadership, +.43, when age is held constant. The corresponding figures for height are +.31 with sociality and +.29 with leadership; with the Olson behavior problem scale, −.18 for sociality and −.32 for leadership. The correlations with weight, I.Q. on each of the two tests used, nursery-school attendance, and health ratings are all less than twice their probable errors. No reliable differences associated with sex, occupational class, size of family or position among siblings were established.

RATINGS SCALES AND INTELLIGENCE TESTS

Discussion of results

Ratings scales. The 4 series of ratings were described briefly in the introductory section. The reliability of the combined ratings of the 12 judges[13] for each scale was computed by correlating the summed ratings of one-half of the group against those of the other half and correcting by the Spearman-Brown formula. The reliability coefficients obtained in this way were as follows: for the Marston introversion-extroversion scale, +.98; for the Olson scale for the prediction of behavior problems, +.94; for the ratings on attractiveness of personality, +.95; and for the beauty rankings, +.91. The average intercorrelations of the various judges on the separate traits is in the neighborhood of +.60.

The reliability of the combined ratings is very high for all four traits. This is due to the large number of judges, and to the amount of time spent by each in observing the children immediately preceding the time of making the ratings. It should also be noted that all except one or two of the judges had had extensive acquaintance with young children previous to the time of making this study and that several of them were acting as part-time assistants in the nursery-school or were using the children as subjects in their own thesis problems. It is probable, moreover, that the method of taking the observational samples has in some measure contributed to accuracy of ratings, in that it insures an equal division of time among all the children observed, rather than too great a concentration of attention upon a few outstanding cases.

Inter-correlations between these rat-

[13] Thirteen students participated in making the observations, but only 12 were present when the ratings were made.

ings are in general not high. On a priori grounds one might expect that many judges would fail to discriminate between beauty and attractiveness of personality, but as the correlation between the two series is only +.08, this seems not to have been the case. Beauty correlated with extroversion to the extent of +.36 and has a negative correlation of −.58 with likelihood of becoming a behavior problem according to the Olson scale, when age is held constant. With the Minnesota I.Q. the correlation is +.29; with the Merrill-Palmer I.Q. the correlation is +.43. Other correlations with beauty are negligible. Attractiveness of personality shows a positive correlation (age constant), of +.42 with extroversion and a negative correlation of −.80 with the Olson ratings. Negative correlations of −.32 and −.28 are also found between the Olson scores and I.Q.'s on the Minnesota and Merrill-Palmer tests.

Of the two intelligence tests, the Minnesota shows a correlation of .78 and the Merrill-Palmer of +.85 between mental and chronological ages. The Minnesota I.Q.'s have a zero correlation with chronological age; the Merrill-Palmer a small positive correlation (+.24). The correlation between the two series' of mental ages is +.90; between the I.Q.'s the correlation is +.67. The correlation between length of nursery-school attendance and Minnesota I.Q. is +.30; between length of nursery-school attendance and Merrill-Palmer I.Q., +.46.

DISCUSSION OF RESULTS

The method of short samples has shown itself to be a useful means of studying the spontaneous behavior of young children in the nursery-school. With continued use of the method, a number of problems have, however, arisen for the solution of which further evidence is needed. It is apparent from the data presented in these studies that in order to secure maximum reliability in the usual statistical sense of the term, observations should always be taken at approximately the same time of day and under similar conditions. Is there a likelihood that this increased reliability may be gained at the expense of a loss in validity; i.e., in the amount of confidence which may be placed in the obtained scores as an index to the child's most typical behabior with regard to the trait in question? The foregoing studies have shown rather clearly that a change of situation does not affect all children in a precisely similar manner. On a priori grounds, therefore, it appears that a truly valid measure of behavior must be based upon observations taken under such a diversity of circumstances as to constitute a representative sampling of the child's daily life. Since in practice this is rarely feasible, the problem resolves itself into a question of determining how many and what kinds of situations should be sampled in order to secure, within a given total amount of time, the most adequate picture of the child's habitual reactions. Unless the observational time is unlimited, the question cannot be answered by an equi-proportional division of the child's daily program, since some situations may provide so few opportunities for the display of a given form of behavior that the greater part of the observer's time is wasted. The study

of compliance is an illustration of the loss in reliability resulting from infrequent environmental stimulation for the display of the trait. It is probable that this factor is largely responsible for the superiority of the lunch-hour over the free-play-hour for the observation of talkativeness. In general it seems to be true that, all other things being equal, the situations which tend to call forth the maximum display of a given form of behavior for the majority of the subjects may be regarded as optimum for securing a reliable series of observations on such behavior. While our data do not permit wide generalization, the fact that talkativeness scores for the lunch-hour were found to correlate more highly with the subjective estimates of 10 independent judges than did scores made during the free-play hour, in spite of the fact that none of the judges had made systematic observations of the children during the lunch-hour is significant. It suggests that the use of a single type of situation for the observation of behavior may not affect the validity of the observational scores to as great an extent as might be supposed, provided that the situation be wisely selected.

A second question of practical import has to do with the optimum length of the single observational sample. Given a certain total amount of time to spend in observation, how may that time most effectively be divided? Here also it seems probable that the answer will differ according to the trait to be observed. For certain very overt and simple modes of behavior, such as physical activity, a glance is sufficient to ascertain what is occurring at any given instant. In these cases our experience has led us to believe that a shorter time-sample—possibly even as short as fifteen seconds—may perhaps yield more reliable data than can be secured by dividing the time into fewer and longer periods. For more complex forms of behavior such as leadership, a longer period is required in order to classify a single event with accuracy. A special study on the optimum length of the time-sample for various characteristic aspects of behavior is planned for the near future.

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The Mental Organization of the Newborn

PAUL HANLY FURFEY, MARTHA ANNE BONHAM, AND MAE KATHRYN SARGENT[1]

GESELL (1) has shown that something analogous to "general intelligence" exists in young infants. The child who is retarded at the age of six months will probably be proportionately retarded at one year. Linfert and Hierholzer (2) have demonstrated the possibility of constructing a statistically valid scale for measuring mental development in the first year. They showed that even at one month there is a general factor underlying the child's responses—a factor apparently similar to the "general intelligence" of the educational psychologist.

The present authors were interested in determining when this general factor makes its appearance. Is it present at birth or is it acquired during the rapid growth which characterizes the first postnatal month? To answer this question a scale of tests was devised and administered to 66 infants in the maternity ward of Providence Hospital, Washington, D. C. Four of these infants were excluded from the final study on account of incomplete data. The remaining 62 subjects ranged in age from 15 minutes to 343 hours with a mean age of 91.73 hours.

The final scale consisted of 17 items; namely, plantar reflex, right and left, leg withdrawal reflex, right and left, hand and foot, reaction to light, convergence of eyes, following moving object with eyes, sucking reflex when a nipple was presented, and reaction to bell, clang, and whistle. The authors were interested in the quantitative measurement of those reflexes rather than in their qualitative descriptions. It was not the purpose of the present investigation, for example, to consider

TABLE 1

Reliabilities of tests for infant reflexes

		RELIABILITY
1	Plantar—left	.761
2	Plantar—right	.581
3	Withdrawal of leg—left	.652
4	Withdrawal of leg—right	.733
5	Grasping—left foot	.902
6	Grasping—right foot	.906
7	Patellar—left	.668
8	Patellar—right	.739
9	Grasping—left hand	.749
10	Grasping—right hand	.857
11	Eyes close at light	.568
12	Eyes converge	.784
13	Eyes follow moving object	.945
14	Lip reflex	.901
15	Reacts to bell	.879
16	Reacts to clang	.799
17	Reacts to whistle	.850
	Mean	.781

[1] P. H. F. was responsible for planning this investigation and for the statistical analysis. M. A. B. and M. K. S. did the actual testing.

TABLE 2

Intercorrelations of infant reflexes

	PLANTAR REFLEX	LEG REFLEX	GRASPING (FOOT)	PATELLAR	GRASPING (HAND)	LIGHT REFLEX	CONVERGENCE, EYES	MOVING OBJECT	LIP REFLEX	BELL	CLANG	WHISTLE
Plantar reflex	×	+.448	+.072	−.053	−.356	+.130	−.105	−.125	−.386	−.105	−.232	−.292
Leg reflex	+.448	×	+.107	−.107	−.128	−.142	−.195	−.224	−.072	−.094	−.190	+.288
Grasping (foot)	+.072	+.107	×	+.021	+.168	+.076	+.379	+.232	+.192	−.018	−.206	−.029
Patellar	−.053	−.107	+.021	×	+.112	−.173	−.093	−.064	−.073	+.332	+.117	+.242
Grasping (hand)	−.356	−.128	+.168	+.112	×	−.473	+.017	−.208	+.875	+.292	−.124	+.581
Light reflex	+.130	−.142	+.076	−.173	−.473	×	+.148	+.045	−.031	−.150	−.253	−.167
Convergence, eyes	−.105	−.195	+.379	−.093	+.017	+.148	×	+.675	+.242	+.008	−.059	+.037
Moving object	−.125	−.224	+.232	−.064	−.208	+.045	+.675	×	+.028	+.455	−.082	+.849
Lip reflex	−.386	−.072	+.192	−.073	+.875	−.031	+.242	+.028	×	−.062	−.211	−.274
Bell	−.105	−.094	−.018	+.332	+.292	−.150	+.008	+.455	−.062	×	+.317	+.534
Clang	−.232	−.190	−.206	+.117	−.124	−.243	−.059	−.082	−.211	+.317	×	+.441
Whistle	−.292	+.288	−.029	+.242	+.581	−.167	+.037	+.849	−.274	+.534	+.441	×

Probable errors vary between .020 and .086.

whether the infant's plantar reflex consisted in flexion or extension. The point was rather whether the reflex was slow and slight or quick and ample.

It was found impracticable to measure the activity of these reflexes by any physical measuring device available to the present investigators. It was therefore decided to use a graphic rating scale on which 2 judges could express their judgments independently. These judgments were correlated and reliabilities of the combined judgments were estimated by the Spearman-Brown formula. The results are shown in table 1. It will be seen that the ratings show a satisfactory reliability for statistical purposes.

The next step was to study the intercorrelation of the various responses. Before doing this the ratings on similar reflexes involving the two sides of the body were combined. That is, right and left plantar reflexes were combined into a single score, right and left patellar reflexes, and so on. It was felt that this procedure was justified because there were few cases in which the corresponding right and left reflexes were not equally active.

The intercorrelations are shown in table 2. If there is a general factor underlying the infant's various responses then the average intercorrelation should be significantly different from zero. The average correlation, however, was found to be .044. This does not seem significant.

A closer analysis of the table reveals certain interesting facts. If intercorrelations affecting one part of the body are considered, the correlation becomes much higher. In the upper left-hand corner of table 2 a square has been drawn around the intercorrelations of a number of reflexes involving the lumbar cord. The mean intercorrelation within this group is .081. Similarly, if a square be drawn about the coefficient of responses involving the cranial nerves—light reflex, convergence of eyes, response to a moving object, and lip reflex—it will be found that the average coefficient within the square is .184. In the lower right-hand corner is a square drawn about the intercorrelations involving the cranial nerves and body musculature. Here the mean correlation is .431.

It may be inferred that the average of all the coefficients in the table, .044, is as high as it is, on account of the coefficient within the squares. This inference is correct. The average of the coefficients in the table which are outside the three squares is .0005—exactly zero for statistical purposes.

These results make possible a tentative answer to the original question. No general factor is discoverable in the mental life of the newborn infant. There are only specific groups of abilities involving specific parts of the nervous system. The infant at birth is not a mental unit. It seems reasonable to suppose that it is the maturation of the nerve tracts which welds these discrete elements into the integrated mental whole discoverable at the age of one month.

SUMMARY

1. A scale involving 17 responses was given to 62 newborn infants.

2. The intercorrelation of the results of these tests proved to be zero after certain intercorrelations involving specific parts of the nervous system had been eliminated.

3. These results suggest that there is no mental integration in the newborn. Integration takes place during the first postnatal month and can be reasonably supposed to be conditioned by the maturation of the nerve tracts.

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The Heilbronner Test for Preschool Children

ROBERTA S. WHITE

THE original Heilbronner test was designed to measure "apperception" or imagination (1). It consists of 12 series of line drawings printed on small cards and representing familiar objects. There are from 3 to 7 cards in each series. On the first card of a series only one or two lines of the picture are shown. In each succeeding card more lines are added until in the final card the picture is completed. These cards are shown to a subject one at a time in the given order and he is instructed to name the object depicted. The more quickly he grasps the meaning of a picture even though some details are lacking, the more proficient he is in the test.

The following study was made with the purpose of seeing whether this test might be of use with preschool children. It was first given in its original form to a preliminary group of 16 children in the Child Institute at the Johns Hopkins University. From the results thus obtained the test was greatly shortened by the elimination of those pictures and series of pictures which were of no value in differentiating levels of ability among the children. This revised form was then given to 31 children at the Institute of Child Welfare at the University of Minnesota and the results studied in the light of chronological and mental age.

PRELIMINARY TEST

The group of 16 children used in the preliminary test ranged in age from 3:0 to 5:4 years with the median at 4:3 years. There were 10 boys and 6 girls. The procedure was as follows. The child was seated in a small chair at a low table. His attention was directed to the table by the experimenter (E) pointing and saying, "I am going to show you some pictures right here." Then the first picture was placed on the table in front of the child while E said, "Tell me what that is." If the response was wrong E said "No," and showed the next of the series, saying "What is that?" This phrase was repeated at the beginning of each new series and whenever the child hesitated too long. When the response was right E said, "That's right," and then showed the rest of the series. At the end of the first series E explained that the pictures were all of the same thing only the first one had just a few lines and the rest had more and more until the picture was finished.

The pictures were shown in the alphabetical order of the letters A to N which designate them. (The letters J and K were omitted from the original test.) A record was kept of every response and of the general attitude of

the child. Leniency was used in counting responses correct, for instance "tick-tock" was accepted for clock, and radio for phonograph, since few children have seen the old fashioned type of phonograph depicted, and it looks much like a radio.

METHOD OF REVISION

The results from this preliminary test showed clearly that a revision was needed if the test were to be useful with preschool children. Table 1 gives these results. It tells the number in the series of the card or drawing which elicited the correct response in that series for each child. These series of drawings represented by letters are arranged in order of difficulty as measured by the number of children which named them correctly. The subjects are arranged in order of age from oldest to youngest. A dash signifies the child was unable to name even the last card of the series.

It appears that the 3 most difficult series, the thermometer, phonograph, and fountain pen, were practically useless since so few of the children were familiar with the object depicted. These were discarded in the revision of the test. The pencil and broom series were also eliminated because of the similarity among the cards comprising each series. The windmill was of the Dutch type which children meet only in pictures, so it too was discarded.

The 6 remaining series were then shortened by eliminating those cards which had little value, that is which in few or no cases elicited the first correct response of the series. As finally revised the test included series with cards as follows:

Clock:	2 cards, Original order in series 2 and 3
Book:	2 cards, Original order in series 2 and 4
Lamp:	2 cards, Original order in series 1 and 3
Bicycle:	2 cards, Original order in series 3 and 5

TABLE 1

Number of card in the series eliciting the first correct response; preliminary test—original Heilbronner

SERIES	SUBJECT															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I. Thermometer	–	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E. Phonograph	–	3	–	–	–	6	5	–	–	–	–	–	6	6	–	–
N. Fountain pen	–	–	–	1	–	–	1	–	3	3	–	–	–	2	–	–
G. Butterfly	3	6	6	6	5	6	–	6	6	–	–	–	–	3	–	–
A. Windmill	1	5	–	6	6	6	–	1	4	1	–	–	4	–	6	–
F. Book	4	1	4	3	4	4	4	3	2	4	–	–	4	2	–	4
H. Broom	4	4	–	1	1	1	4	1	1	1	1	–	1	1	–	1
B. Lamp	3	1	1	1	1	1	–	1	1	1	–	1	2	1	–	3
L. Bicycle	5	4	–	–	5	4	5	4	4	6	4	4	5	5	4	5
D. Pencil	2	1	4	1	1	4	4	4	2	1	1	–	5	1	–	1
C. Telephone	2	7	6	6	6	4	3	6	6	6	4	7	6	3	7	7
M. Clock	2	2	2	3	3	2	3	2	3	3	3	3	3	3	3	3

Butterfly: 3 cards, Original order in series 3, 5 and 6
Telephone: 4 cards, Original order in series 2, 4, 6 and 7

RESULTS WITH THE REVISED FORM

Thirty-one children were given the revised form, 17 of whom were boys and 14 girls. Their ages ranged from 2:2 to 7:5. I.Q. averaged 108.6 with a range from 85 to 152. The I.Q. was taken from previous tests, Kuhlman-Binet for 13 of the older children and the unpublished Minnesota test for 18 of the younger.

The procedure was identical with that of the preliminary test except that the method of exposing the cards was more standardized. Instead of merely placing them on the table in front of the child they were shown one at a time through an opening $2\frac{1}{2}$ inches square in a large envelope of black paper which was tacked to the table top. Each card was glued to a strip of black paper which served as a handle to remove it, thus exposing the next card in tne series. Lighting was from the left and above.

Scoring followed the method used by Clara H. Town (2). One point was given for each picture correctly named, so 15 was the maximum score obtainable. Leniency was again used. Thus "lantern" and "light" were accepted for the lamp, and "tricycle" and "kiddie car" for the bicycle.

The scores ranged from 0 with the youngest child to 13 for one of the oldest, and averaged 7.5 points. The girls show a superior score even though their average age is less than that of the boys. This is probably explained by the higher I.Q. of the girls.

	Boys	*Girls*
Age	3:8	3:7
M.A.	3:11	4:1
I.Q.	104.4	113.8
Score	6.8	8.4

TABLE 2

Number of card in the series eliciting the first correct response—revised Heilbronner

SERIES	SUBJECT																											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Clock	1	1	1	2	2	2	1	2	2	1	1	1	1	2	2	1	1	1	1	1	1	1	1	–	1	2	1	–	–	1	–
Book	1	1	1	1	1	1	1	1	2	1	1	–	1	1	1	1	–	–	1	1	1	–	1	–	1	–	–	–	1	1	–
Lamp	2	2	2	2	2	1	2	2	2	2	2	2	2	–	2	–	–	–	2	2	2	–	–	2	1	–	–	–	2	2	–
Bicycle	2	2	2	2	2	2	1	2	2	2	2	1	2	2	2	2	2	2	2	1	2	1	–	2	–	1	–	1	1	2	–
Butterfly	1	3	3	3	2	–	3	1	3	–	–	1	–	–	–	–	–	–	0	–	1	–	–	–	–	–	–	–	–	–	–
Telephone	3	3	3	3	2	2	2	3	2	–	2	3	3	–	2	2	4	4	2	2	2	2	2	3	4	–	2	1	2	2	–

Correlation between C.A. and score was .83±.04, between M.A. and score .74±.06. No significant correlation was found between score and I.Q.

Table 2 shows that every card of the 6 series was useful in eliciting the first correct response of a series from at least one child. The first card in the "book" series was recognized as a book by 21 children yet 9 failed to get it correct on the last card. The "butterfly" was too difficult for two-thirds of the children or else unfamiliar to them. Pictures of other objects more usual in a child's world could be included advantageously in the test.

The use of this test with children

under 3½ years may be critized on the grounds of the language element. Scoring is difficult when the child's enunciation is poor. The young child has a tendency to repeat the same syllable over and over again whether it has any connection or not. Furthermore the test lacks manipulation, which is often necessary to hold a child's attention. But with older children of the preschool age the test might be of definite value in measuring "imagination," or better still as one of a series of tests for that purpose.

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Variations in the Responses of Infants During First Ten Days of Post-natal Life

EDITH S. BRYAN

THE problem of the present research is the consideration of those factors present at birth and in the earliest days of the new-born infant's life which may lend their influence to the determination of his reactions and behavior. Such a study presupposes careful observation of the various stimuli which affect the child and also consideration of all activities which are the resulting effect of known or unknown stimuli. This study[1] includes careful note of the condition of the mother during pregnancy and observation of the type and length of labor and delivery, together with the reactions of the infant on each of the first ten days of life, to certain constant stimuli presented under conditions as nearly identical as can be set up with the new-born child. Attention was given to the cry, the reactions to light and sound, grapsing and the Babinski reflex and to various types of muscular activity. Aside from this stenotyped work of an experimental nature careful note was made of any unusual activity or condition produced by an unknown stimulus.

In order to make the study as complete and exhaustive as possible the investigator studied the physical and other conditions of the mother prior to labor, attended the mother during labor, observed the reaction of the child on delivery and for some time succeeding delivery, and made examinations concerning the reactions of the child to its accustomed environment. Definite stimuli were given under experimental conditions twice each day for a period of ten days. The tests were made both during the waking and during the sleeping periods of the child. The waking period was taken immediately succeeding the bath which just preceded a nursing period, both factors being considered as lending aid to determining the most wide awake period of the day. The sleeping period was chosen as that immediately succeeding the nursing period when the child seems to have fallen into the soundest slumber. The number of mothers examined were 64 and the

[1] This investigation was made at the Psychological Laboratory, The Johns Hopkins University. The mothers and infants studied were in the maternity ward of the University of Maryland. To the data obtained for the Baltimore infants were added similar data for Mexican children and for some negro children in California. To the members of the staff of each hospital coöperating in the study the author acknowledges gratitude for the opportunity given to her and for their active and helpful coöperation in securing records. The continuation of the study by the author is in progress at the University of California.

number of infants from these mothers was 66, as 2 pairs of twins occurred in this group. For certain reactions additional infants were observed as in the case of the Babinski reflex when 100 infants were tested.

REACTIONS TO LIGHT

In this study it has been observed that following the normal and not too difficult birth of a vigorous child the infant generally remains awake for the first two hours or more after birth, and that during this period the child has a tendency to lie with wide open eyes and eyeballs rolling about with a fair amount of coördination. Careful note was made of all who opened the eyes immediately after birth and 15 of the 66 opened the eyes at once, either prior to other muscular activity or simultaneously with it.

In one hospital the practice was to administer the drops of silver nitrate as soon as the cord was tied and cut; and as this was completed within the first two or three minutes the eyelids were retracted and the drops administered before the infant had voluntarily opened the eyes. It gave the appearance that this practice delayed the normal opening of the eyes somewhat, as in a second institution the administering of the drops was delayed until the baby was removed to the nursery. The percentage of infants, in this second group who opened the eyes immediately was somewhat larger than in the first group. The average delay was not more than fifteen minutes, however, in the first group.

In the study of the effect of light stimuli the following materials were used: for the first three days the stimulus was the Winchester Flashlight No. 5911, charged with No. 935 Ever-ready Unit Cell; for the succeeding days the light used was the French Ray O Lite charged with Ever-ready Unit Cells No. 950. The latter light was focused to a point at 1 foot but used 3 feet from the child for the fourth and fifth day and thereafter focused for 3 feet and flashed at that distance.

The light was flashed on the face of the child three times during each experimental trial. Two such trials were made daily, one during the sleeping period and one trial during the period when the child was awake. The newborn gives a much more acute reaction to a sudden light thrown on the face during the first three of the neo natal days than it does during the succeeding seven days. This fact holds whether the child is asleep or awake. It was repeatedly observed that, during the first three days of life, when a light falls on the eyes the child frequently gives a start, the lids are more tightly closed, a frown appears, the lips also are frequently closed more firmly and if the light persists the head is moved from side to side, is thrown back or turned well away from the source of light. The reaction to the light is more extreme when the child is asleep than when it is awake, as during the waking periods the reaction consists of a quick blinking of the eyes accompanied frequently with a downward movement of the head and a frown less severe than when asleep.

After the first three days are passed, as a rule, these reactions become notably less severe, until by the fifth to seventh day the reaction is very mild and generally wholly disappears before

the tenth day so that a light flashed in the face of a sleeping child brings no reaction whatsoever. When the stronger light is flashed in the eyes of a child that is awake, there will frequently be one blinking movement and then the eyes will open wide while the child gives the appearance of looking directly at the light or alternately looking at it and away without paying any attention to the presence of the light and without further blinking. The reaction seen during the first three days seems much like that described by Preyer (8) as occurring from the tenth day on. The fact that the reaction was not generally seen after the fifth to seventh day in the present experimental study may be due to adaptation of the organism to the stimulus, after the application of the stimulus for from three to five successive days.

At no time was any of this group observed to follow the light or other bright object during this ten-day period of observation. The investigator was always dressed in white when with the mothers and infants and several times an infant had the appearance of fixating the investigator's face or white dress but it was probably the brightness or whiteness that attracted the attention and held it momentarily. One such instance was caught in a picture. Further description of this incident is given under the section on muscular activity.

Conclusion

The eyes of the vigorous new-born infant have a tendency to open voluntarily as one of the earliest muscular activities and the eye-balls roll from side to side.

The eyes of the new-born infant soon adapt to light. The reaction to a light flashed in the face is more severe when the child is asleep than when awake. The adaptation generally occurs within the first five days and what reaction is seen after that time is of a very mild nature.

The average infant does not follow a light or point of brightness with its eyes during the first ten days of its life.

Occasionally an infant, in the first ten days of life, will fixate a light or bright or white surface for a notable period of time.

HEARING

The subject of hearing in infants has been much discussed by observers and experimenters in child psychology. It was formerly rather universally thought that a new-born child was wholly deaf. There has been a variety of opinions expressed as to when the hearing was attained and opinions varied from the idea that it was gained a few hours after birth to the belief that the sense of hearing was not present for days. Those who believe the child to be deaf after birth are Preyer (8), Tracy (12), and Rasmussen, while Miss Shinn (10) possibly holds this view as she reports, "The baby showed no signs of hearing anything until the third day." An opinion quite opposed to this is held by Tanner (11), and Watson (13), who contend that the infant hears the first day, although even these writers seem to admit that the sense of hearing does not develop alike in all infants.

In this study three forms of auditory stimulation were used.

For the deeper tones a little hand

bell was used which had a salient pitch of approximately 512 vibrations frequency, one octave above middle C. The procedure tried first with each infant was to hold the bell sidewise and lifting the clapper to the upper side let it fall to the lower. The fall of the clapper was through a distance of 2 inches. The bell was within 1½ inches of the ear.

The second procedure was to ring the bell sharply as close to the ear as possible without touching the child.

The third procedure was with the use of the Galton (Edelmann) whistle which was sounded within 1 inch distance from the ear at pitches of ten, fifteen, twenty, twenty-five and thirty-five thousand vibrations and each pitch sounded three times with an interval of silence between. Each of these procedures was followed twice each day for the ten days, once each during both the waking and sleeping period, the periods being the same as those described in the preceding experiments. Each sound was given three times.

The result of the first procedure was absolutely negative. To the sound of the bell elicited by the fall of the clapper through the distance of 2 inches (the diameter of the bell rim), there was no reaction that was distinguishable with any child at any time, sleeping or waking, during the ten days of trials.

The result of the second procedure, the sharp ringing of the bell, appeared positive although some doubt might occur to the minds of certain investigators as to the validity of the interpretation. It is well known to those whose daily life is spent with the newborn that an infant is frequently seen to give a sudden violent start, similar in appearance to the strong muscular start given by an adult just dropping asleep. This sudden start of the infant has repeatedly been observed by the investigator in the absence of any dis-

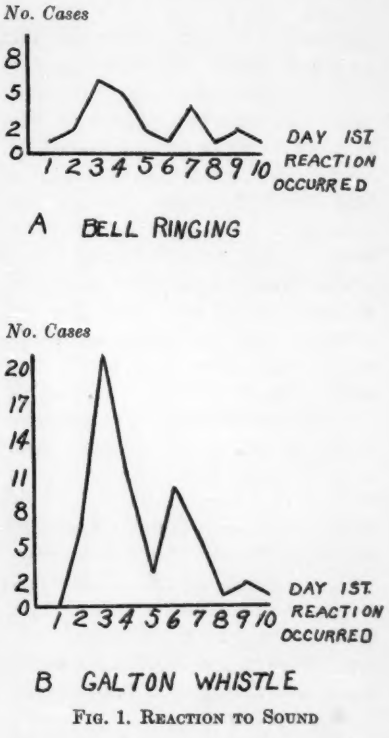

FIG. 1. REACTION TO SOUND

cernable external stimuli. In one hospital where the nursery was five stories up on the quiet side of the hospital grounds and well isolated by corridors from any noisy portions of the house within, this phenomenon was frequently seen and in practically all of the infants. The conception of the cause as that of

jar seemed equally untenable as the building was of brick and concrete and no trains passed near. Unless these little organisms are as delicate as the seismograph they could not be considered as registering jar in this way. Bearing in mind this start from an unknown cause it is difficult to determine just when a stirring is due to the stimulus of sound and when it is due to this unknown factor mentioned above. The reaction of the sound of the ringing bell most frequently apparent was that of stirring or turning toward the sound. The reaction of blinking was that next in frequency while a severe start or a cry were more rarely observed.

This second experiment of sound was only tested on 31 cases. In 2 of these no reaction was observed in the 20 trials given (2 on each of ten days). In 4 other cases a seeming reaction was observed only once with each child, so that these cases were eliminated as possibly belonging to the type of case cited above where the cause for the start is unknown. The occurrence of the time of the first reaction is shown in figure 1. This indicates the first reaction to sound as being first observed for 17 out of 25 cases between the third and seventh day, 3 occurring prior to that time and 4 being seen later.

The reaction, if such it could be considered, appeared very erratic, after what seemed to be a definite reaction to a given stimulus several days might elapse before any further reaction was seen. In no case was a reaction seen to appear each day succeeding the first appearance. The reactions noted were of six different types, arranged in ascending order of frequency: opening of eyes, crying, starting (rather violent), blinking, turning toward the sound and simple stirring. In all these tests made on all the infants the reactions were seen the following number of times:

Reaction	*Number of occurrences*
Opening of the eye	5
Crying	6
Starting (violent)	15
Blinking	17
Turning toward sound	18
Stirring	45

With the Galton whistle (Edelmann) the findings were somewhat similar to those resulting from the bell ringing. A reaction to the sound would apparently be seen one day and then be utterly lacking for several days following. In only one instance was the reaction observed each day after its first occurrence. Of the 75 cases tested 5 gave no evidence at any time of hearing the whistle; 7 showed a reaction only once in the ten days and were therefore disregarded for the same reason as quoted above; 41 gave a reaction and in succeeding days gave, once or more than once, a similar reaction to the same stimulus.

In only a few instances was the child observed to give the appearance of hearing the human voice. The most notable instance was that of the child who turned to the investigator while standing on the table on the sixth day, a full description of which is given in the section on muscular activity. Several other infants were observed to turn the head on the ninth and tenth day and fixate the face of the investigator who in each case was holding

the babe in her arms. The "reaction" seemed to be that of "listening" while the investigator talked or crooned to the child.

In each institution where the cases cited were observed the nursery was at the back of the building where little noise was heard from the street. In one place, however, the accident department was just below and across a narrow patio from the nursery and the ambulance would frequently swing into this fatio, by way of the alley, with a warning scream from the siren. Frequently when this occurred the investigator was standing before a number of the baskets observing the babies. At no time did she see any start or other evidence of a reaction to this sound.

Conclusion

New-born infants do not all give evidence of hearing in response to bell and whistle stimulation during the first week of life.

The average new-born infant gives no evidence of hearing ordinary sounds during the first two days.

Many infants give evidence of hearing from the third to the seventh day.

Some infants give the appearance of listening to ordinary talking or crooning before the tenth day.

TASTE AND SMELL

Definite stimuli to elicit olfactory and gustatory responses were not given. Some observations that contribute to knowledge of such responses during the first ten days of life were made. While the infant seems to be sensitive to strong odors or to distinctly different taste qualities according to previous studies, the experience in this present experiment would indicate they were not acute enough to detect human milk from different mothers nor from modified cow's milk. A number of children, due to a sick condition of their own mother, were given milk from other mothers who had more than enough for one child and who were willing to have it pumped for the needy child. Thus the infants sometimes had milk from another mother or mixed milk from a number of mothers or at times even modified cow's milk, without showing any lack of willingness to accept it and without presenting any notable facial expression or other unusual reaction. When, however, in the preparation presented to the child lactic acid was used it appeared to be distinctly displeasing to the child. The nipple was not seized as eagerly as when mother's milk was presented but was pushed from the mouth with the tongue repeatedly with facial expressions or contortions which seemed to indicate distaste or dislike. After the preparation with lactic acid was presented for a number of days in succession this dislike seemed to disappear, accomodation seemed to occur, and the milk was taken eagerly.

REFLEXES

A study of the reflexes in the newborn has occupied much time and interest, but reports are so conflicting and at times so incomplete, as to make the summation of results extremely difficult.

The multiplicity of description

seems to give confusion to the picture since the different experimenters describe their procedure, as well as the results, in differing expressions which are difficult to interpret in common terms. Failure to report the exact age of the child or range of ages of any specific division of a group showing one particular type of response also adds to the indefiniteness of results found.

Some state as Koffka (5):

"That a considerable number of reflexes are aroused by stimulation of the skin. Among these, one that is typical of the newborn infant is the so-called Babinski reflex, which after a few weeks is supplanted by the plantar and does not again appear in the normal adult."

Burr (2) reports that Gottfried Engother, 1905, found that in 232 children, in the first week of life, and with sound nervous systems, the plantar consisted of dorsal flexion of the toes (*Babinski*). M. A. Leri in 166 infants found extension of the toes on stroking the sole, the rule, at birth. John Lovett Morse concluded after the examination of 254 infants during the first twenty-three months of life that, "It is evident that there is no constant plantar reflex in the first year." In his own study Burr (2) examined 69 infants, from one hour to ninety days old, and reports,

"In 9 instances, though the toes moved, the movement was so erratic that I could form no judgment. In 19 others there was no movement of the toes, of any kind, no matter what part of the sole was stimulated. In 25 cases there was definite extension of the toes, and in 16 there was flexion."

Preyer (8) and Watson (13) both report the Babinski as present at birth.

Sherman (15) reports on this reflex,

"The reflex was elicited by stroking with a dull pointed pencil from the anterior plantar surface downward in the midline. When the stimulus was followed by extension of the great toe (positive Babinski), 5 additional stimuli were given in succession, within less than one-half minute. Age variation of infants examined was from one hour to twelve days. Flexion occurred in 57.3 per cent of the cases and extension in the remaining 42.7 per cent. When the stimulus was repeated as described above, the positive Babinski was quickly followed by flexion in 31 (75.6 per cent) of the 41 infants showing extension in response to one stimulus. The remaining 10 cases showed a persistent extension of the toes. The final response was a flexion in 86 (89.6 per cent) of the total 96 cases."

Since the Babinski reflex is said to be found in such a comparatively short span of time, two years or less, it is highly essential that note should be made of any deviation of its appearance, or disappearance as to point of time. The consideration of this time element may be one of the most important factors in disclosing the real significance of this reflex. Some questions which present themselves as worthy of study are:

1. In what percentage of children is it present at birth?
2. Is there any correlation between the condition of labor and consequent condition of the child with the presence or non-appearance of this reflex at birth?
3. Even though found in all races alike, as some investigators affirm, does it appear in all races at the same approximate age?
4. How wide is the range of time for its disappearance and is there any correlation between the health condition of the child and its time of disappearance?

In the study of this reflex by the present writer the stimulus was given to each infant three times on each foot each day, at the period when the child was awake and also three times on each foot each day when the child was asleep. A soft blunt pencil was used for the stroking. The leg of the infant rested across the palm of the left hand of the observer and the forefinger and thumb clasped the leg very lightly just below the knee. The stroke was begun between the great toe and the second toe and followed the midline almost to the heel. The reason for lifting the pencil before reaching the heel was because it was found that stroking the heel greatly accentuated the reaction of jerking away as though from tickle. Another notable bit of reaction was that the free foot almost invariably pushed against the worker's hand as though to free the imprisoned foot.

There were 100 infants studied in all, including 68 whites, 9 Mexicans, and 23 negroes. In general the results were as varied as indicated in the reparts of the workers cited above. It should be remembered that this study covered only the first ten days of life, so that differences found here would not have the same interpretation as differences found in a wider span of time. In no case was the Babinski found on the first day. The following discussion is a consideration of the experiment done with the child awake. In the group of white infants 17 gave the reaction definitely the second day, 13, the third day, and so on as indicated in figure 2, all but 6 showing the reaction by the tenth day; 3, however, showing great variability, the reflex being present one day and absent the next. In the group of 9 Mexican children 1 gave the reaction the fourth day, 2 the eighth and 1 the ninth, the other 5 not showing the reaction at any time during the ten-day period. In the group of 23 negro children, 1 showed the reaction the eighth day and 1 the ninth, and the other 21 not at all in the ten-day period. This shows a definite racial difference in the early

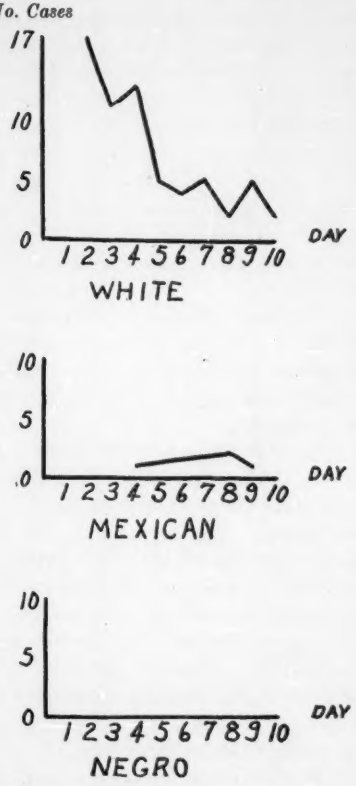

FIG. 2. APPEARANCE OF BABINSKI REFLEX

days of life. In regard to the colored infants it was noticeable that the reaction to other stimuli on the foot was not so acute as with the white. They did not jerk the foot away so quickly upon tickling or tapping the foot as the white children did.

Plate I, *A*, shows the reaction of one infant, on the third day, a definite plantar reaction which was secured from both left and right foot. Plate I, *B*, shows the same infant with the reaction of the fifth day (two days later), this time a definite Babinski. The picture was snapped, as can be seen, before the pencil had traveled very far and the fanning is not as complete as it was, a few seconds later, but, nevertheless, it clearly indicates the reaction. It proved in this group to be rather usual for the two feet to give the same reaction.

There can be no one type of reaction cited as appearing before that of the Babinski. In some infants the plantar was definitely seen. In many an erratic moving of the toes occurred which may or may not have anything to do with the stimulus. In some, and this was especially noticeable in the negroes, the stimlus applied in the earliest days elicited no response whatsoever but the foot lay in the experimenter's hand absolutely inert.

One interesting factor was seen a number of times with several of the white infants. Among those who developed the Babinski rather early in the ten-day period, and some others who remained in the hospital over the ten-day period, so this special experiment could be carried on into the eleventh and twelfth day, it was seen that the reaction did not wait for the stroke down the foot but occurred immediately upon the leg being taken into the hand in readiness for the usual stimulus. The interesting point here is whether the Babinski can be elicited by the stimulation of other areas and whether there may be at times a factor of learning involved. This reaction was seen a number of times under entirely different circumstances. It is clearly shown in one of the later illustrations in muscular activity occurring when the infant is hanging, supporting its weight by its own grasp of the investigator's fingers, Plate I, *C*.

Another peculiarity which came to light in this experiment was the fact that the reaction on stroking the foot is not always the same for a given infant when the stimulus is given with the child awake as it is when the child is asleep. For example: Ten of the colored children when asleep gave a very definite Babinski reaction, once, before the tenth day. This occurred only once with each child and between the sixth and tenth days. These infants, at no time, gave this reaction when awake. The white children did not show the same ratio of difference but 4 of them showed the same peculiarity, the Babinski appearing in the sleeping child before it did in the child when it was awake.

Although the Babinski reflex does not appear in all infants at the same time, and although it is variable in its constancy of appearance we are able to draw some rather definite conclusions concerning it.

1. In the majority of white children the Babinski reflex may be expected by the tenth day of life.

2. In the colored children the ap-

pearance of this reflex is delayed longer than in the white, not appearing in general until some time after the tenth day.

3. There seems to be a difference in time of appearance of the reflex when the child is awake and when it is asleep, usually occurring earlier in sleep.

4. The stroking of the sole of the foot probably is not the only stimulus which excites this reflex action.

5. A further study of this reflex may add something to the evidence on learning in these early days.

6. In some cases the reflex appears in the left foot before it appears in the right.

It may be that a prolonged and still more thorough study of this reflex will throw considerable light on the subject of prenatal and early postnatal development and on the earliest stages of learning. A further study of racial differences will be most interesting and possibly very enlightening.

THE CRY

Seemingly little has been done toward a careful study of the cry of the child. It has been accepted as one of the first and by some the very first activity of the new-born. It is so considered by Kant, Kirkpatrick (4), Lowden (6), Watson (14), Rasmussen (9), Gesell (3), Preyer (8) and Allport (1). Preyer (8) describes the first cry as purely reflexive but later as "Piercing and persistent in pain; a whimpering in an uncomfortable position; suddenly waxing to unexpected intensity and again decreasing quickly when something is desired and not obtained;" while Allport characterizes it as "weak, rhythmic, tremulus and unvaried," and Gesell speaks of it as "The very first behavior event after birth," and Watson (14) observes "The birth cry occurs at the moment the respiratory centers are stimulated after birth."

This report deals with the time and conditions of the cry responses. The quality of the cry as to pitch and pattern is merely described as apparatus for recording the sounds was not available for this study.

The cause for the first cry has not yet been determined, as there are several factors which seem adequate stimuli for this activity. It could well be the reaction due to the release from the pressure given by the uterine contraction and by that of the abdominal muscles as the fetus is forced through the pelvic passages in delivery. There are times when the sudden, abrupt, sharp cry, given immediately on delivery of the head, has every appearance of a protest against rough handling. This type of cry is more apt to occur in a normal, quickly expulsive delivery of the multipara. Such a cry is sharp, rather deep and given with a full intake of breath and is welcomed by the attending physician and nurse as indicative of complete expansion of the lungs. At other times the cry does not come until the entire body has been exposed to the air and may be due to the stimulus of the change of temperature from that experienced in utero to that of the room in which the delivery occurs. This cry is not usually so explosive or sharp and the inspiration is frequently not so deep as that which occurs with the cry coming immediately on delivery. It must frequently be further excited by tapping on the

soles of the feet or along the spine or by briskly rubbing the back. The child is never considered in the best condition until a vigorous cry with deep intake of breath has been secured. At times the cry is weak and more or less rythmic and has the appearance of being, not so much the result of a definite external stimulus as that of an inward discomfort or lack which might be described as an air hunger. Such a cry may indeed be concomitant with an incomplete expansion of the lungs. There is in it a complaining sound of discomfort. When such a cry as this comes as the first reaction, further stimuli are added until a sharper cry with deeper intake of breath is secured. It has been frequently noted with premature infants and other infants in poor condition at birth that each inspiration is accompanied with a little moan. It is difficult to determine whether this moan is indicative of discomfort or a mere whistle through the air passages.

When the birth is by Caesarian section the reaction seen is of two types: The one in which, for some reason, the mother has been kept under an anesthetic for a considerable period, shows all the signs of simple anaesthesia and after the lapse of a brief interval, (ten minutes in one instance) the infant cries feebly and breathes spasmodically and at the end of one-half hour shows normal breathing and crying. The other type delivered in this manner gives a sharp vigorous cry immediately upon being lifted from the uterus and continues crying vigorously while being carried from the operating room to the nursery. If the cry be the reaction to external stimuli in these cases, where the anaesthetic has not affected the infant, the cause would seem to be either the difference in temperature or reaction to handling.

The variation in the frequency, intensity, and pitch of this first cry seems to be closely related to the physical condition of the child and possibly to the type and length of the period of labor. There are times when the period of labor has been greatly prolonged and the child has every appearance of exhaustion that the cry is characteristically weak, short and intermittent. When the child is asphyxiated, as occurs at times when the cord is around the neck or when forceps have been used to interrupt prolonged and difficult labor, the cry may not come until some time after the intake of several breaths and also after definite muscular activity has been observed. One such case was noted in which the labor began at 11:00 a.m. on Monday and the first stage lasted until 1:00 a.m. on Tuesday (fourteen hours). The second stage lasted from 1:00 a.m. until 2:00 p.m. (thirteen hours) when, as very little progress had been made, it was interrupted by a mid-forceps delivery. Upon delivery the heart-beats were 35 per minute and no respiration, so that artificial respiration was set up and the alternate warm and cool bath was used for stimulation. Muscular activity (which will be described in the section on this subject) was set up before crying, and several inspirations were also observed before crying, and the child was fifteen minutes old before satisfactory crying was observed and thirty-five minutes old before spontaneous

vigorous crying was noted. Thus crying, though generally either the first or one of the first observed activities need not necessarily be so.

Within the first twenty-four hours the cry may take on very definite meaning. A child whose clothing has become wet will frequently in the first day give a cry of protest. At first, this is often a short, staccato cry with intervals of silence and muscular relaxation. It almost seems that the infant is waiting to see if any response will come to the demand for attention. If the response is prompt there is frequently no further sound during the handling in changing from wet to dry clothing nor on being laid back in the bassinet. If, however, no attention is paid to the first cry, others follow until in many cases the cries come in quick succession with very short intervals between for the intake of breath. If the infant works itself into a fury of crying, it will frequently continue during the process of handling and die into a wail and sobbing cry after being returned to the bassinet. In such instances there will frequently be seen the repeated intake of a sobbing breath after the child has dropped to sleep. When the cry reaches the state of continuous protest, it is generally accompanied by a vigorous kicking of the feet and a less rhythmic but rather constant waving of the hands. Some infants in this fury of crying will hold the breath until they are purple in the face giving a very good picture of the temper tantrum.

It is customary to find that a child which is crying in this unrestrained fashion will hush immediately upon being lifted out of its bed and remain quiet even when some moments elapse before its real wants can be given attention. This has been repeatedly observed as early as the first three days of life. In one nursery where there was an average of about twelve babies it was customary for the nurses to take up one child after another, dry it, and put it back in its basket. When all the babies were dried they would then be carried out to the mothers to nurse. Frequently babies would be discovered crying who were not wet. This could be accounted for by hunger as it was nursing time. Such babies, when handled and discovered to be dry, would be placed back in the basket awaiting completion of the preparation of all the babies to go out to nursing. Such babies were often observed to quiet down and remain quiet with widely open eyes during this waiting period, although no want, except possibly that of being handled, had been supplied. If, however, more than a limited amount of time elapsed before they were taken out to nurse they would again take up the cry. This had all the appearance of awaiting the completion of the satisfaction of their wants which as such could only be ascribed to learning.

The cry of the new-born varies in pitch, intensity, and continuity and to one accustomed to caring for babies has in it elements considered as expressing emotion. The emotions attributed to the infant on the basis of the difference in the type of its cry at different times are general discomfort, actual pain, and rage. Some people who care for infants would add a fourth as hunger. It seems difficult to distinguish the cry when hungry

from that of seeming general discomfort. The quality of the cry when expressing general discomfort is rather monotonous in pitch, staccato-like and intermittent at first becoming gradually more incessant but without very long tonal quality. The condition called pain is indicated by a rise in pitch from the inception of the cry to its completion. This gives the impression commonly spoken of as piercing or shrill. If the pain is accompanied by an increasing physical weakness this may drop to a moan, but even in this latter state the rising inflection is often noted. The cry attributed to rage is characterized by a greater duration of tone, although frequently the sound drops out entirely, while the mouth is still wide open, the breath is still held, and the face becomes almost purple. In this type of cry the mouth is more widely opened and the dropping away of the sound seems to be due to the closing of the air passages of the throat, while the mouth is still open. This would account for the purpling of the face and the whole picture is an excellent representation of rage whether the child has that emotion or not. The child crying in this manner can rarely stop crying as quickly as can be done in the cry from discomfort. It is in this type of cry that most frequently tears are seen in the very young infant, and this also is the cry which is most apt to be followed by intermittent sobbing breaths after the wants have been attended to and even after the infant has fallen asleep. This type of cry has with it a peculiar, characteristic muscular activity. The kicking of the feet is not so rhythmic as in the more monotonous cry ascribed to hunger. The movement is more abrupt and given with more vigor. The knees are frequently drawn up to the abdomen and both feet thrust out simultaneously instead of with alternating movement as is the customary action.

One infant, the seventeenth of this series, had every appearance of intelligently demanding attention as a pleasure satisfaction and knowing when it was granted. From birth it was an unusually pretty baby and consequently was fondled, by some of the nurses, more often than any of the other babies. By the sixth day it was noted in the nursery that this baby cried frequently when neither hungry nor wet and that the cry would cease immediately when and during the time it was fondled, generally taking up the cry as soon as it was put back in the bassinet. The infant seemed in a normal physical condition so the general conclusion in the nursery was that it desired attention, expressing its desire with a cry and showed satisfaction and content when this desire was granted. This tendency was well developed by the sixth day. As has been said above, the first cry may be entirely reflex but thereafter it very soon has the appearance of learning and of functioning as the expression of desire as well as emotion.

MUSCULAR ACTIVITY

The quiescent child assumes, in the period following close upon birth, a position somewhat similar to the position in utero. It has often been observed that in handling a new-born child during the first bath that intense crying nearly always is evoked when the lower limbs are straightened to a

line parallel to the line of the vertebrae, and also when the arms are lifted directly out from the side on a line from the shoulder. The writer has frequently thought that the necessary straightening of the limbs in completing the birth passage may be one of the important stimuli in setting up the all important birth cry. This seems to be a tenable assumption to make in view of the previously noted fact that this cry comes most unfailingly with the quickly expulsive delivery of the multipara and as this type of delivery means sudden straightening of the body line it may well constitute the first kinesthetic pain or discomfort and be the necessary stimulus for the cry.

In speaking of this early post-natal position Lowden (6) makes the comment "The legs are drawn up as in foetal life," and Moore (7) reports, "Immediately after birth, the child continued to lie in a position which closely resembled that of the foetus. The early movements were generally conditioned in range and direction, by the maintenance of this position."

The infant, however, exercises at times the greatest activity with arms and legs, kicking and slashing in all directions, and this with some infants from the moment of birth. Koffka (5), says, "We find the new-born child capable of movement whenever external stimuli come in contact with his senses; that is, whenever the equilibrium of his condition is disturbed." This activity is sometimes seen even before birth is completed. One infant, a multipara presentation, after the delivery of the head and the hand, quick as a flash before the rest of the body could follow grapsed the vulva. The expulsive power of the uterine contractions broke this hold, and it immediately grasped the cord so firmly it proved difficult to loosen the tiny fingers. The infants are frequently observed to grasp the cord, and also the instrument, the doctor's finger or a bit of gauze in the first few moments of life, even before the cord is tied. It has been said that this grasping is a reflex as they so quickly grasp whatever touches the hand, but like the sucking reflex, it is not invariably present.

The procedure in this test was as follows: After repeated trials the experimenter found that the infant grasped her thumb as readily and as firmly as it did the wooden rod used by some other worker. The use of the thumbs had the advantage, in that the experimenter could feel when the infant's hands were slipping and close her own figures down over the tiny ones of the infant before the baby fell and so prevent the shock of falling. It seems unwise to cause unnecessary startle to a new-born babe when we know so little of the condition of the nervous system at this time and so cannot judge what these shocks may mean in the ultimate development of the nervous system and emotional life.

Grasping is rather generally found and in some persists in a marked degree for the entire ten days and probably longer. Some workers have reported as very strong at birth and report the child as able to support its own weight with this grasp. The writer has found this true with a few isolated cases but not in the majority. With this group the strength of grasp has been

PLATE I. *A*, plantar third day; *B*, Babinski, fifth day; *C*, grasping, fifth day (note Babinski); *D*, standing, weight borne on feet, ninth day

sufficient, with some, to merely lift the shoulders from the table while the back, bent as a bow, permits the head and buttocks to touch; others were able to support the weight of the head and shoulders; and a very few, that of the entire body. One noticeable factor was that many of the infants who had the ability at birth to support a part or the whole of the body, would lose it in the days immediately following but after a few days, which time seemed to correspond fairly well with the period of starvation, would again show the ability. As the greater number could support only the shoulders or at most the shoulders and head this decline in ability referred largely to that power. It seemed a rather remarkable fact that nearly all the infants who acquired the ability to support the body weight retained it from the day acquired until the end of the tenth day when the study closed.

In Plate I, *C*, are shown the feet of a baby sustaining its own weight by the grasp of its hands. This is the characteristic position of the feet during this experiment, as they are always drawn up as in utero. It is the infant whose grasp during the act of birth was so remarkable. This picture also illustrates that the Babinski reaction may be induced by other stimuli. It is shown very clearly here and in both feet at the same time. This reaction frequently occurs during suspension. Here as in some other reactions studied, either practice increases the strength and surety of the reaction or else the reaction is more certain to appear with increasing age during these earliest days. Evidence of the ability to sustain weight is seen in figures 3, 4, and 5 which show the number of cases developing the ability, for the first time, in each of the first ten days of life. As reported earlier, when once present the ability was never entirely lost during the ten days, although the infant could not always be stimulated to so react but only during its period of greatest activity, when it seemed to be most wide awake.

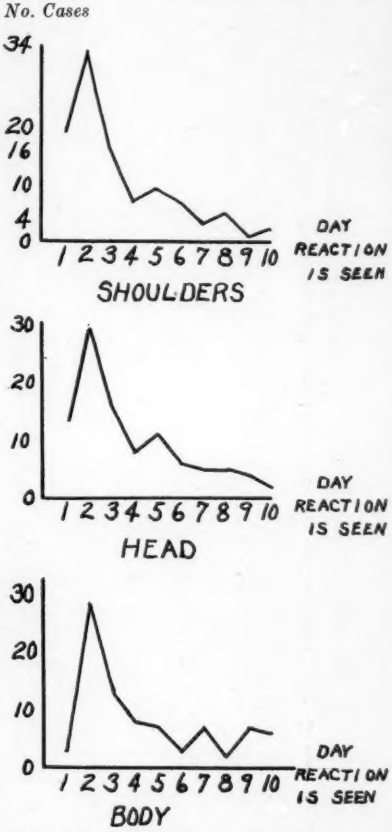

FIG. 3. GRASP WITH LIFT OF SHOULDERS; OF HEAD; OF BODY.—ENTIRE GROUP

Another activity which may be indicative of the development of the infant is that of lifting the head when placed prone on the face. The procedure here was to place the child face down on a hard surface, table if possible, with the face down flat and the arms and legs straightened out from under the body as much as possible. The reaction was to turn the head to one side, lift the head, draw the knees up under the body, and the elbows in to the side with, frequently, the elbow or hands brought almost together under the chest. Some really striking results were seen from this procedure. One infant on the second day pulled the knees up, then pulled the elbows forward and raised the head at right angles to the line of the spine and turned the head from side to side as though looking about. After a few seconds of this the right arm straightened out so that the weight was transferred from the elbow to the hand and with a little extra push the infant rolled over on its back, to the left.

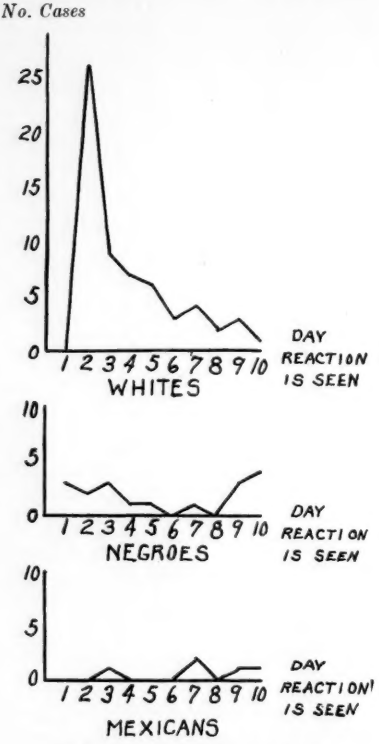

FIG. 4. LIFT OF ENTIRE BODY

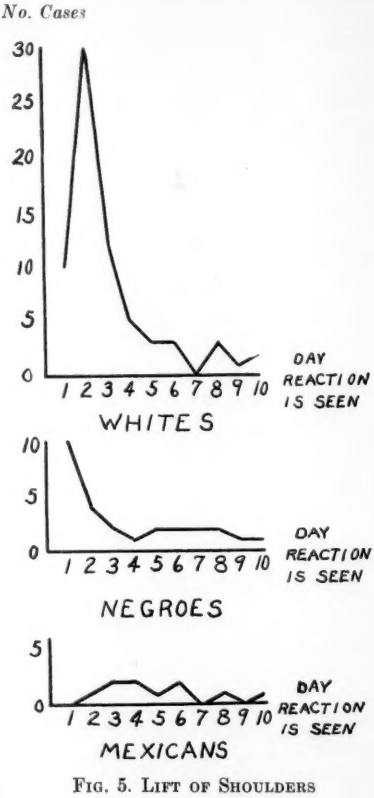

FIG. 5. LIFT OF SHOULDERS

The movement was accomplished so slowly, in all about forty-five seconds, that the infant was not at all frightened or disturbed by the change of position, but lay "looking" up and around it. Unfortunately not being prepared for this incident, no photograph was obtained of it. The same infant showed far greater facility, in movements of this kind, than the average, but never duplicated the whole procedure during the ten days. It may be well to note here that in much of this experimenting the infant was without clothing or had only a shirt and diaper. The average infant would probably develop better muscle control if not so hampered by restricting clothing and other barriers.

The position to which the infant brings itself when lifting the head is well illustrated in Plate II, *A*, where the knees are well forward and the elbows to the sides and the hands under the chest. With the head up in this manner he could turn it several times before it would drop down as though a bit too heavy for sustained support. The ability to lift both head and legs at the same time, resting only on the abdomen and pushing up with the hands is also illustrated in Plate II, *B*. This picture was taken on the tenth day but the same reaction was seen from the second day on. Plate II, *C*, shows the same position but this infant had very remarkable muscular strength. This picture taken on the sixth day represents a reaction seen from the first day. The child was delivered by a Caesarian section so was not exhausted by a long labor and delivery. The hands are both visible and it was notable that the baby, remaining in this position, head well up, would shift the weight from one elbow to the other and move the free hand turning it over. In the picture the weight is in the left elbow and forearm while the infant turns to the right and moves its right hand rather freely.

In this group, there were 10 infants that lifted the head well off the table during the first twenty minutes of life and of these 4 pulled the knees well forward, up under the body. As infants so often sleep more quietly on the face than on the back or side it is well to early learn their ability to move and adjust their position so that there need be no worry about smothering.

The infant in Plate II, *D*, also a Caesarian section case, showed in creeping an exceptional muscular development and good coördination. When the picture was taken, unfortunately, the baby had lost its balance and the head went down but the fold in the baby's blanket which acted as a table cover show the direction of travel. In all the baby made several inches of progress, and this on the fifth day. Another infant on the eighth day crept forward 6 inches (the full length of space on the table until the head touched the wall) twice in one minute. After the first forward creeping the experimenter pulled the infant back by the feet, thus straigtening the legs but the baby pulled up and covered the distance the second time. This infant covered the 6 inches with the head in the air. This, however, was an unexpected performance and the camera was not ready for a picture. The final picture of this series, Plate II,

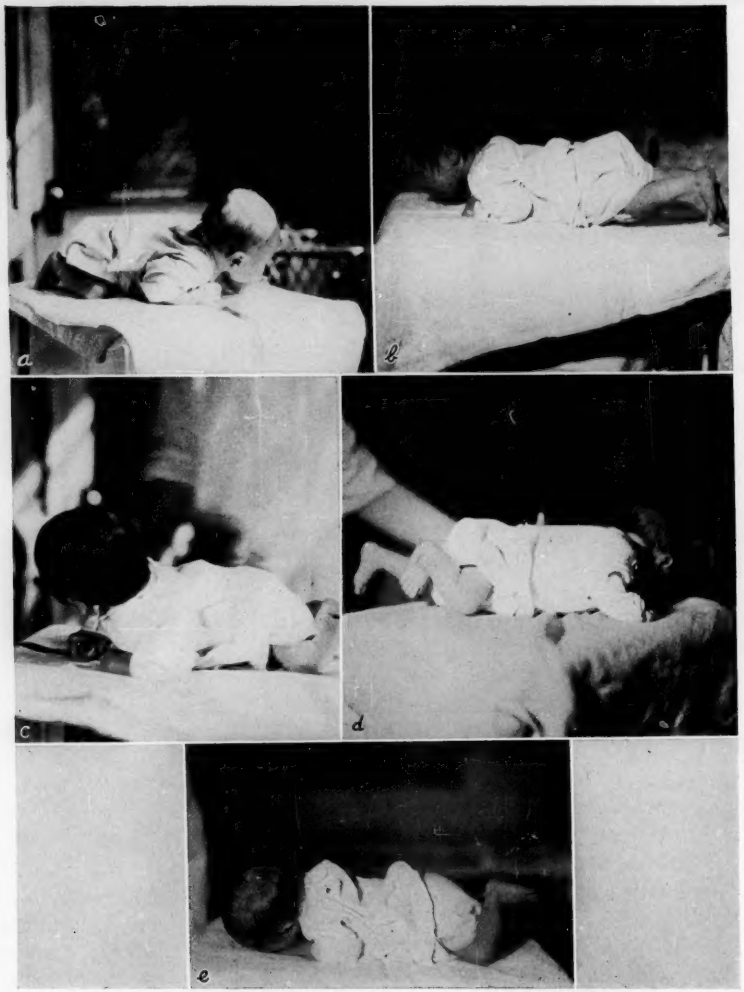

PLATE II. *A*, fifth day; *B*, second day; *C*, sixth day, seen first day; *D*, creeping, fifth day; *E*, frequent position—rarely lifting head—prolonged delivery

E, represents an infant whose delivery had been prolonged especially in the second stage and was finally interrupted by a forceps operation. The infant's head was much molded with considerable overlapping of the frontal and occipital parietal bones. This infant lifted and turned its head at times but was apt to collapse into this prone position or frequently to remain in this position seemingly unable to lift head or at least receiving no stimulus to lift up as is the custom of most of the babies in these first days. This is the same infant that showed the remarkably clear plantar reaction up to the third day and the equally clear Babinski on the fifth day and thereafter. Two other infants, when turned on the face and given something against which to press the feet, displayed the ability to move forward in creeping fashion in these first ten days. One moved across the table (18 inches) twice on the seventh day and was able to repeat the performance each day thereafter during the study. The other exhibited this ability the first time on the ninth day and repeated again on the tenth day. Each of these last mentioned infants was a primipara but, although delivered by different physicians, each was assisted by a mid-forceps delivery, and was in splendid condition showing good muscular activity immediately after birth, also gave a vigorous cry, opened their eyes immediately after delivery and gave an early appearance of all expected reactions.

In the last group of 35 infants in this study, 9 were primiparas with the assistance given of a mid-forceps delivery, in each case the doctor stating that otherwise the labor would have been greatly prolonged. It is interesting to note that 8 of these 9 showed notable muscular activity and a normal breathing immediately after birth; and the expected reactions in all other circumstances. They were not as exhausted as many primiparas who come through an unassisted labor.

An interesting form of coördination of movement was shown by a newborn who was delivered with forceps, had heart-beats, 35 per minute, and respiration not set up. Resuscitation was resorted to (the warm and cool bath). While the infant was in the warm bath before respiration was well set up it suddenly began a treading motion with its feet which was perfectly rhythmic and regularly alternating at the rate of 80 per minute, with the exception that in that time the left foot dropped 10 beats while the right foot lost none. A doctor and two nurses were present with the infant and all counted momentarily to observe the rhythm. It had all the appearance of swimming as the body was submerged all but the face.

Another bit of muscular strength and control is shown in Plate I, *D*, The incident is as follows: The writer picked this baby up to put it on the table for the picture of the head lifting. In putting the baby down its feet touched the table first and it immediately stiffened bearing all its weight on its feet. Realizing this the writer immediately removed the right hand and loosened the left hand so no support was given, although afraid to take the left hand from behind the baby for fear it would crumple and fall. The camera was in position so the writer cried out to the photographer, in an

excited and probably shrill voice, "Take the picture, quick, quick!," whereupon the infant lifted its head and seemed to look directly into the face of the writer and speaker and at the same time threw out its right hand and lifted the left arm and so maintained its balance. It was at this moment the picture was snapped. It is interesting to note the way the toes "dig in" to the table and the little fingers are extended as is characteristic in balancing. This baby not only stood alone on the ninth day but appeared to hear the sharp sound of command and seemed to fixate the speaker's face.

Conclusion

1. The new-born infant has considerable ability for sustained muscular activity and tension.

2. This strength and ability has a tendency to increase with the age of the infant.

3. The movements preparatory to lifting the head appear similar in all infants.

4. Creeping is possible even in this very early period, as is also the power to support the body weight on the feet.

5. In one instance this remarkable muscular strength and control was associated with appearance of hearing and fixating.

GENERAL CONCLUSIONS

The foregong study has led to some very definite conclusion concerning the variability in time of appearance and in constancy of human reactions at birth and in the ten days immediately following birth.

In its reaction to light, the infant tends to show a greater reaction in the first three to five days than at any subsequent time and generally reacts more strongly during the sleeping than during the waking periods. Although the eyelids open voluntarily, as one of the earliest muscular activities, there is very little evidence that the eye will follow a light or point of brightness during the first ten days of life. Occasionally, however, an infant will appear to fixate during these early days for a notable period of time.

The evidences of hearing do not come in these first ten days as a usual thing but they are occasionally found from the third to the seventh day. Such evidences usually come in response to a sharp sound or high tone although more rarely the infant gives the appearance of listening to ordinary talking or crooning before the tenth day.

In these early days the infant seems to be sensitive to strong odors or to different taste qualities; but to have the ability to adapt quite readily to that which at first seems distasteful.

Much has been said about the appearance and significance of the Babinski reflex in the infant. Although it does not appear at any given time and although it is not always constant after its first appearance some rather definite conclusions have been reached in this work. As an example, we find in the majority of white children this reflex may be expected within the first ten days, while with colored children it is rarely seen by that time. Also there seems to be a variation in the age at which it can be elicited in the

child awake and in the child asleep. The stroking of the sole of the foot is not the only stimulus which excites the reaction and there seems to be a tendency for the reaction to appear in the left foot before it is seen in the right.

One of the first activities, observed, namely, the cry, certainly shows wide variation in pitch, intensity and continuity, and if carefully studied may throw much light on the early development of emotions. While the first cry may be merely a reflex, early subsequent cries certainly bear the appearance of the result of learning.

The new-born infant has considerable ability for sustained muscular activity and tension, and this strength has a tedency to increase with age in the normal child. The movements preparatory to lifting the head, when lying face down appear similar in all infants and rather more purposeful than random. Creeping is possible with some infants in the first week as is also the power to support the entire body weight on the feet.

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